SEPTEMBER 21, 1959

R RESEARCH AND DEVELOPMENT

Product Engineering

MCGRAW-HILL WEEKLY ON DESIGN, MATERIALS AND PRODUCTION

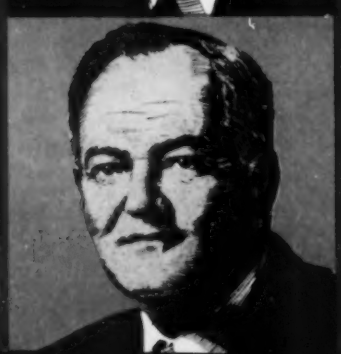
DR. ALLAN T. WATERMAN
Director,
National Science Foundation

JOHN W. McCORMACK
House of Representatives

SHOULD WE HAVE A DEPARTMENT OF SCIENCE?

see page 36

DR. T. KEITH GLENNAN
Administrator, National
Aeronautics and
Space Administration



HUBERT H. HUMPHREY
U.S. Senate

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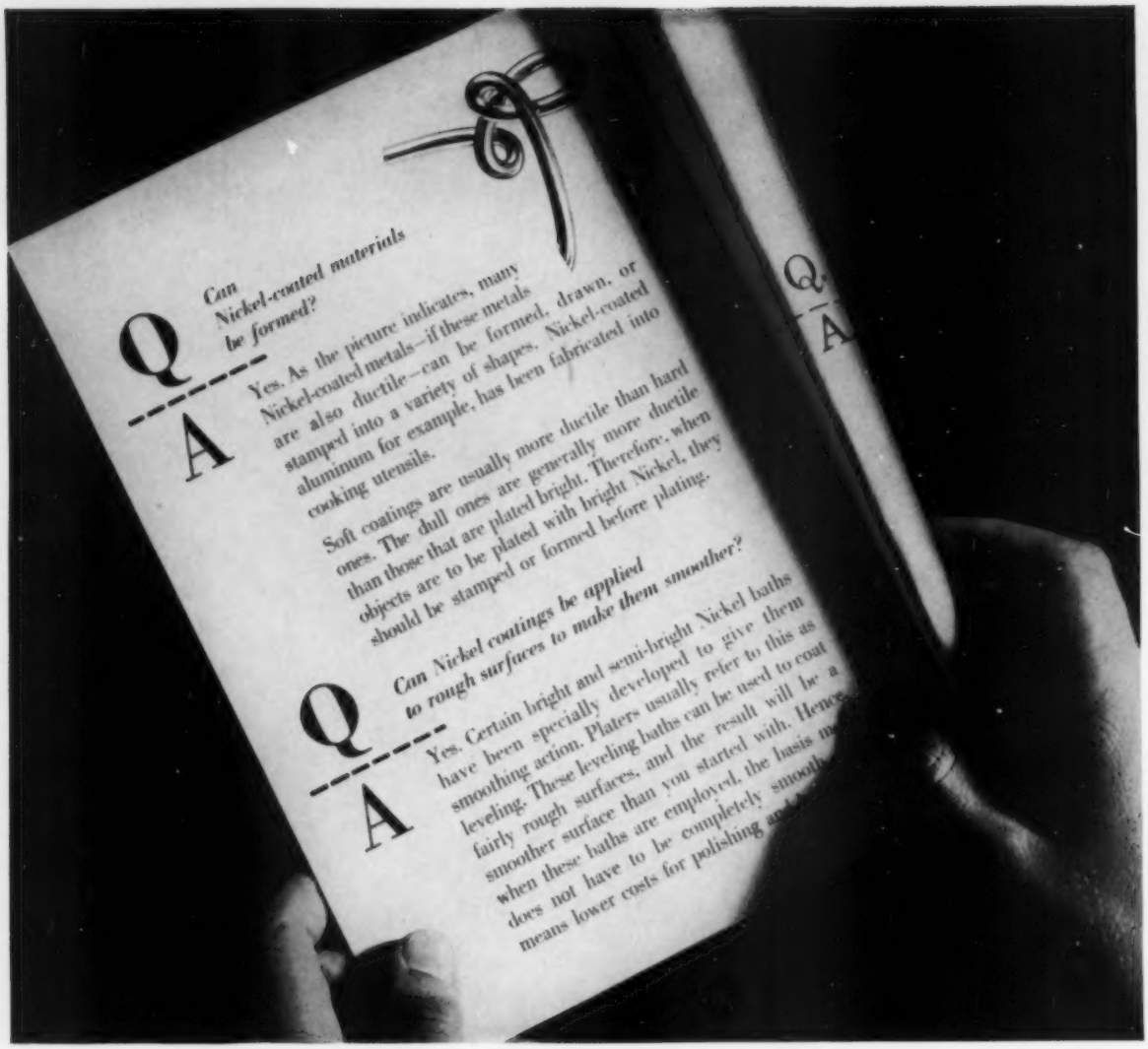
Q
A
Can Nickel-coated materials be formed?
Yes. As the picture indicates, many Nickel-coated metals—if these metals are also ductile—can be formed, drawn, or stamped into a variety of shapes. Nickel-coated aluminum for example, has been fabricated into cooking utensils.
Soft coatings are usually more ductile than hard ones. The dull ones are generally more ductile than those that are plated bright. Therefore, when objects are to be plated with bright Nickel, they should be stamped or formed before plating.
Q
A
Can Nickel coatings be applied to rough surfaces to make them smoother?
Yes. Certain bright and semi-bright Nickel baths have been specially developed to give them smoothing action. Platers usually refer to this as leveling. These leveling baths can be used to coat fairly rough surfaces, and the result will be a smoother surface than you started with. Hence, when these baths are employed, the basis m
does not have to be completely smooth
means lower costs for polishing

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the DESIGN issue

for September 28

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  Check this list of modern methods and materials compiled by an expert in drafting-room procedures.

- **How to write specifications for anodized finishes**
  Change the alloy, its surface preparation, or the coating process and your finish won't be the same.

- **How to measure preload and play in ball bearings**
  A roundup of special and commercial devices to check bearings for preload, radial play and end play.

- **How to choose fixed resistors for power and control**
  A 3-step technique that starts with the load and picks the right resistor to handle it.

- **5 Cardan-gear mechanisms**
  These gearing arrangements convert rotation into straight-line motion, without need for slideways.

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Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

R and D RESEARCH and DEVELOPMENT news issue

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Product Engineering ..... SIDELIGHTS

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● **The truck on our cover,** with its crane and winch, reminds us of some ground-support equipment we saw recently used to pull missiles out of storage and over to the launching pad. One of the crew rides under the rocket; he watches a series of gages and adjusts valves for dangerous combinations of temperature and pressure. The one we met figures to cash in on his experience. He's writing a book for the Christmas season to be called "Under the Missile Tow."

● **Technical development uses many talents,** we know (p 32), but the National Cash Register Co really went overboard in an ad we saw the other day. To do basic research in data processing they want a man with a PhD in biochemistry and interested in basic mental processes such as logic, memory, stimuli, etc. They plan to study complex neuron net activities and copy them in data-processing systems. At last we seem to be taking as our model the best computer of all—the human mind.

● **Government-supported science** (p 36), particularly in space, is getting a lot of argument from men who say, "Why are so many millions being spent on such nonsense as shooting a lot of hardware to the moon? There's plenty to do down here in roads, in schools, without wasting money on things like that." Some people answer, "Because it's there." Others, "Because of the great value of what we'll learn." Still others, "Because the Soviets are doing it." You can stop trying to think up excuses. The wife of the first fish that crawled out of the ocean followed him—complaining all the way—but she followed him.

ABP September 21, 1959

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How to select the exact heating element to meet your product requirements

Here's condensed information from General Electric to help you get the most economical heater for your products.

CARTRIDGE HEATERS

• **Applications**—Efficient, self-contained heaters, for use singly to provide a "spot" of heat, or grouped to heat larger surfaces. Perfected for use in process machinery and for localized heating requiring close thermal control: dies, platens, molds, extrusion and injection barrels, gluepots, compound pots.

• **Features**—Durable nickel-chromium resistance wire packed in insulation and sheathed in metal tube.

• **Ratings**—30 to 2800 watts—Sheath temperatures: brass (750F); nickel-silver (1000F); chrome-steel (1200F)—Over-all lengths: 1½ in. to 2 ft.—Diameters: ⅜ in. to 1.293 in.—115v to 230v.

IMMERSION HEATERS

• **Applications**—Offer clean, economical method of heating various liquids in tanks, kettles, jackets and other containers. Suitable for immersion in water, oil, alkaline solutions, nickel, copper, chrome, plating solutions, mild sulphuric acid baths and salt baths.

• **Features**—Long life—Easily installed—Easily controlled—Sealed terminals—Excellent insulation and heat conduction.

• **Ratings**—Both through-the-side and over-the-side models available—Sheath materials: copper, nickel-silver, stainless steel, Inconel and lead—115v to 230v—Wide variety of models from 650 to 10,000 watts.

FIN TUBULAR HEATERS

• **Applications**—Especially suited to forced-convection air heating applications, such as air ducts with forced-air circulation, blower-type electric unit heaters, car heaters, recirculating ovens, industrial processes requiring heated air blasts for drying, baking, testing or pre-heating.

• **Features**—Large radiating surface per unit length—Fins sturdily attached by brazing—Quick heat transfer—Nonoxidizing rust-resistant finish—Durable construction.

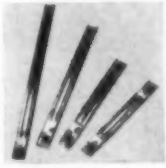
• **Ratings**—Wide variety of shapes available—Sheath temperature: steel (850F)—Watts: up to 100 per linear inch.

TUBULAR HEATERS

Applications—Applicable to practically every low-temperature (1500F or lower) requirement, whether heating liquids, air, soft metals, or metal surfaces. Typical applications: ovens, ducts, platens, pipes, space heaters.

• **Features**—High-quality resistance wire, insulated in metal tubing—Heaters bent to conform to almost any shape, cast into metal, located in drilled holes, grooves, or spaced away from surfaces.

• **Ratings**—Standard ratings, 500 to 5000 watts; special ratings available—Sheath materials: steel (750F); nickel-silver (1000F); stainless and Inconel (1500F); copper (212F in water).



STRIP HEATERS

• **Applications**—Designed for direct clamping to surfaces. Typical applications: process machinery, drying ovens, matrix scorchers, warming tables, glue tables, water baths, drying cabinets, pipelines, incubators, valve and pump houses, telephone switchboards, roll heating, packaging machinery.

• **Features**—Uniform heat distribution—Corrosion-resistant sheath materials—Easy to install—Moderate cost—Uniformity.

• **Ratings**—Provided with offset terminals at one end or terminals at each end—Sheath materials: Aluminized-steel (1000F); Chromized-steel (1200F).

METAL-MELTING HEATERS AND POTS

• **Applications**—Feature cast-in immersion heaters for melting lead, babbitt, tin, solder, type metal and similar metals up to 950F. Applications: dip soldering of subassemblies, railway and repair shops, electric service shops, printing plants, manufacturing plants, remelting metals.

• **Features**—Heat generated right in metal for quick heating, low radiation losses—Heater easily replaced without interrupting production—Reliable, safe, economical—Can be tied in with automatic temperature control.

• **Ratings**—Standard melting pots—Wt. 50 to 2000 lbs—Watts: 750 to 30,000.

OVEN HEATERS

• **Applications**—Designed for such applications as baking, japan, foundry cores, drying, low-temperature drawing ovens, and for general air heating applications in which there is free movement of air by convection. Heaters used in recirculating type ovens for core baking, paint drying, tempering, air heating in ducts, placement inside oven.

• **Features**—Easily mounted on side walls of oven or in ducts—Wide range in heater ratings and combinations of heaters.

• **Ratings**—Temperatures: Two models available: 750F-1000F, and up to 1200F.

VANE-TYPE HEATERS

• **Applications**—Used for air and surface heating applications: baseboard heaters, pipe heating, platen heating, valve and pump heating, drying cabinets and ovens, process machinery, compound tanks.

• **Features**—Rugged tubular construction resists mechanical shock and vibration—Large, 1¾ in. wide radiating surface—Low heat density: 25 watts per linear in. of vane; 14.3 watts per sq. in. of heater surface—Can be easily formed—Convenient mounting holes.

• **Ratings**—Variety of models from 500 to 2500 watts—115 to 230 volts—Over-all lengths: 24 to 104 inches—Maximum operating temperature 750F.

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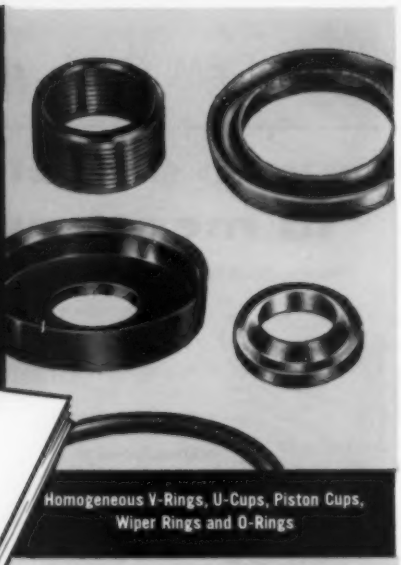

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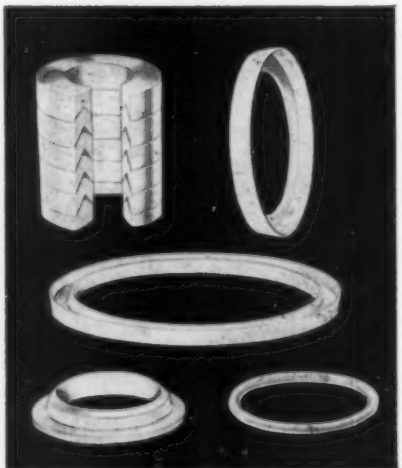

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DEVELOPMENTS TO WATCH... American

Solar furnaces can be a source of cool light . . .

. . . to promote photochemical reactions and achieve efficient conversion of solar energy, says Stanford Research Institute.

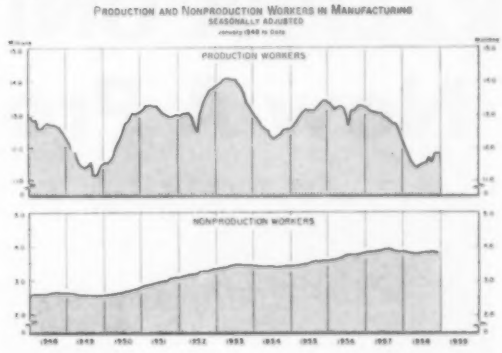
A solar furnace is normally considered a heat source. But R. J. Marcus and H. C. Wohlers have found a way to use the light and avoid the heat. In their setup, a modified Erlenmeyer flask, with an internal cooling coil, serves as a sample holder. It is so placed that light from the furnace mirror enters normal to the conical top of the flask and is focused inside the cooling coil. Ice water is pumped continuously through the cooling coil, and temperatures can be kept surprisingly low, particularly if the sample is one that absorbs radiation primarily in the visible and ultraviolet, rather than the infrared, wavelength range.

A "self-powered" X-ray tube . . .

. . . is being developed by Waite Mfg Div, Picker X-Ray Corp, for the AEC. Only preliminary investigations have been made thus far; but it does seem possible to devise a tube in which the radiation from a radioactive isotope will provide a source of electrons for operating the tube, and replace the electrical power supply now used. Radioisotopes are, of course, used directly as X-ray sources; but an isotope-activated tube might offer a number of advantages in operation and application.

Booming market for maintenance and handling equipment . . .

. . . as well as for office equipment can be foreseen in the tremendous rise in nonproduction (indirect) workers in industry in the past decade. As the chart shows, even when total number of workers dropped sharply, indirect labor continued to rise, on a real as well as a percentage basis. This indicates a growing need for equipment to make maintenance, handling, and other "indirect" operations as nearly automatic as possible to keep down costs; and, of course, a booming opportunity for office machines.



Nearly ⅓ of the total labor force now falls in the "nonproduction" class, Dept of Labor figures show.

An efficient heat-storage system is needed . . .

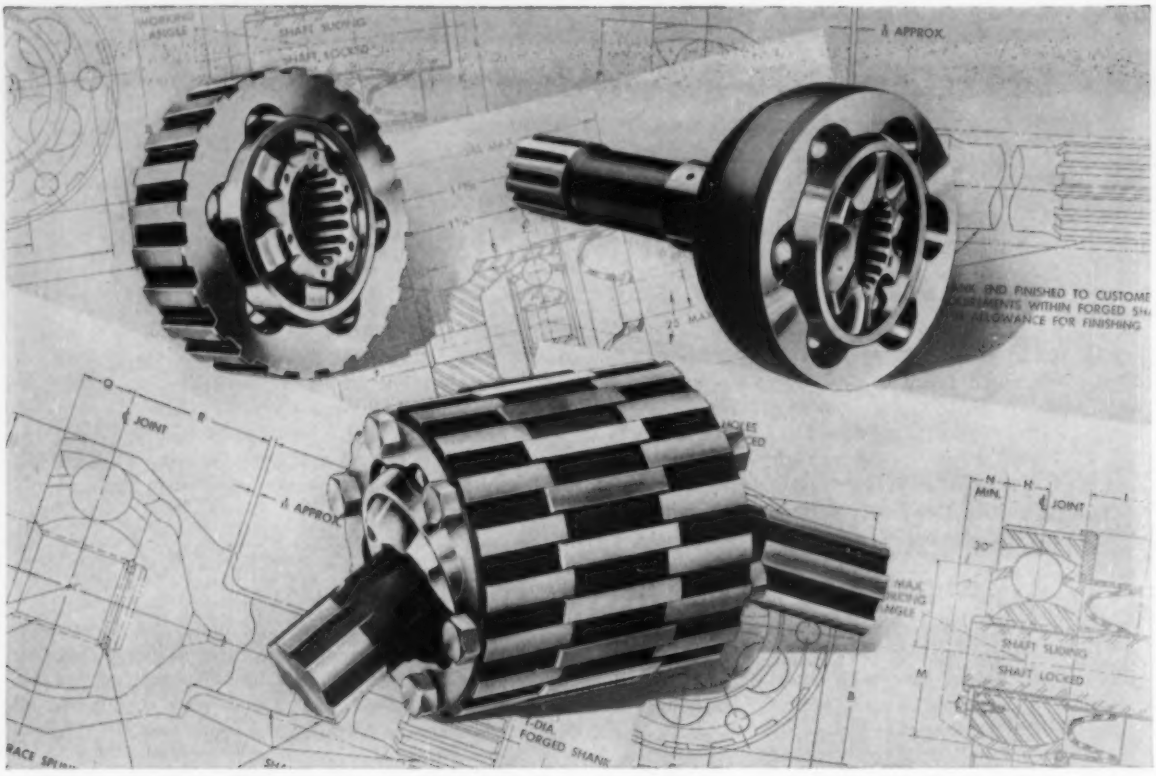
. . . if the heat pump and electrical resistance heating systems are ever to become practical for general use in the north. The reason, says Edison Electric Institute: efficient heat storage seems one of the most promising ways to reduce peak loads and thus keep overall charges down.

How can heat be stored?

There is no ready-made answer, EEI finds. The safe, small-volume storage apparatus, requiring only "design engineering" to make it ready for commercial production, has not been discovered. But two reports recently prepared for the EEI indicate half a dozen possible systems worth exploring. One report, from Comstock and Wescott, suggests investigation of three basic systems: heat of hydration, using calcium oxide and water; heat of fusion, using sodium hydroxide; and chemical reaction (as in the formation of magnesium hydride). It also points to the need for improved insulation to make such systems economically feasible.

Battelle Memorial Institute's study turned up three other possible routes: high-temperature storage, charged by resistance heating; condenser-side storage (using water or paraffin waxes); and evaporator-side storage, charged with the "free" heat fusion of water. Of these, Battelle believes the first offers the most immediate promise. For a system of this type, water, ceramic oxides, or fused salts might be used.

A limited number of copies of the two reports is being made available by EEI. —ARG



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DEVELOPMENTS TO WATCH...

World-wide

Stronger V-belts, fan belts, tires . . .

. . . and mechanical rubber parts at lower cost are promised by Canadian Industries Ltd as it announces a new process for bonding polyester fibers (Dacron, Terylene) to rubber.

Until now, use of these fibers—especially in tires—has been somewhat limited by difficulties in securing a good bond between fiber and rubber. But their high strength and dimensional stability has spurred the search for a better, less expensive system. Now, CIL thinks it has the answer, predicts far wider application of the fibers in industrial goods as well as their eventual use in tires.

Microporosity and ductility of steel castings . . .

. . . can be correlated on a quantitative basis, says British Steel Castings Research Association. With a new "semi-microradiography" technique, they say, they are able to obtain an exact count of micropores in any given area, and thus compare defect structures obtained by various production methods.

For these studies, they use specimens ground to 0.020 in. thickness or less, and high-resolution X-ray plates that provide good definition at magnifications of 20 to 30 times.

Investigation of the effect of pouring temperature on ductility is now underway, and studies of the effects of changes in composition and of other processing techniques are planned.

Automatic slowdown equipment that can be applied . . .

. . . to "any industrial process where material is coiled on to a reel and uncoiled again" has been developed by English Electric Co, London and Stafford, England.

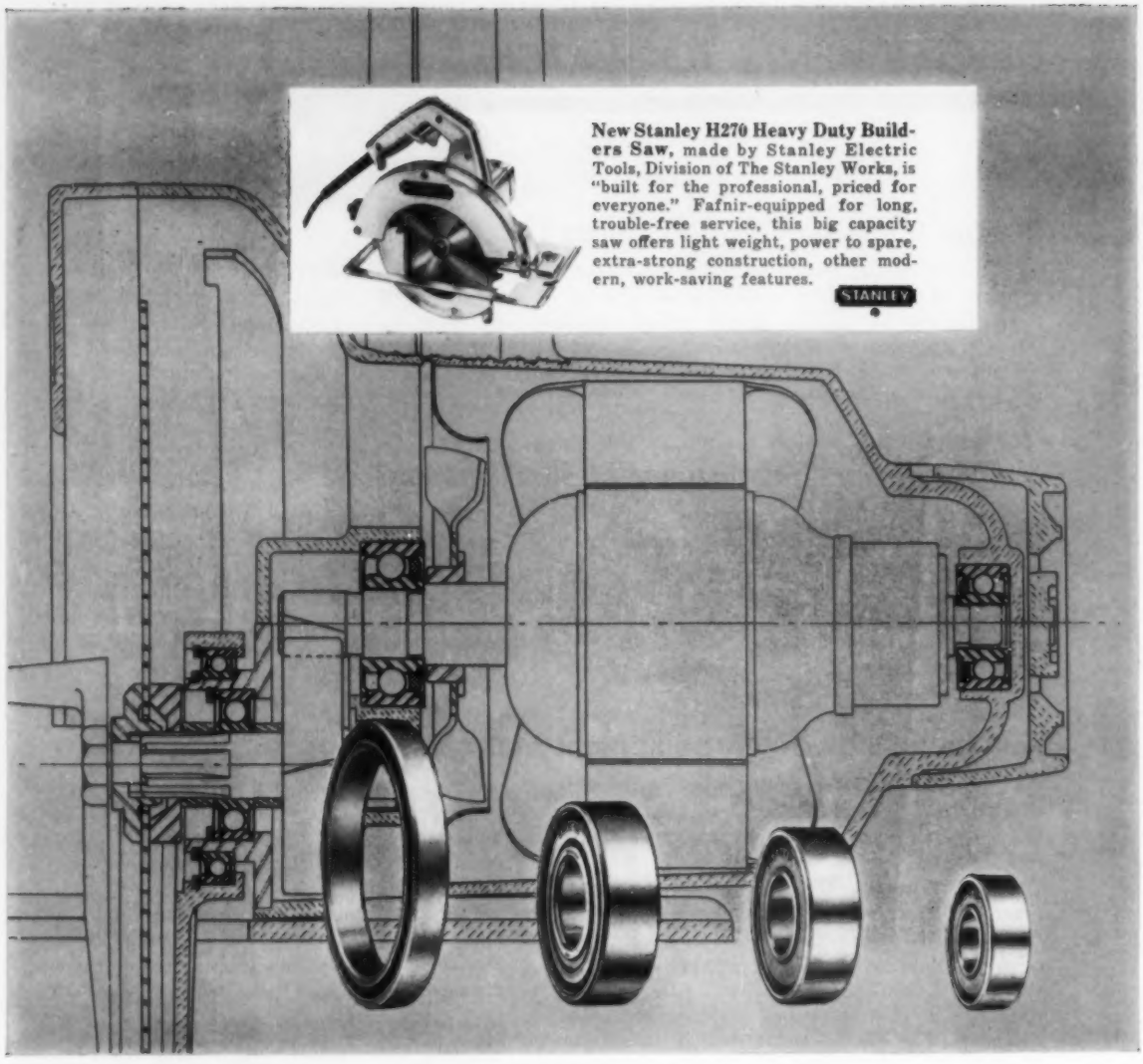
There are two types: one, primarily mechanical; the other, electronic. Both are designed to determine "the latest safe point" to slow down a mill (or other sheet- or web-processing equipment) for reversing, and both operate by counting the turns on reversing reels during coiling and uncoiling. The advantage: The equipment can minimize premature slowdowns (or the damage caused by tardy action) and make it possible to increase production by as much as 10%.

The mechanical unit is a roller rheostat system (see photograph) that provides a steadily changing electrical output during each 50 turns wound on or off the reel. A sensitive magamp or relay then compares the number of turns indicated by the rheostat with the square of the strip speed (obtained from a unit contained within the slowdown device and excited from the mill-driven pilot exciter or tachogenerator). Magnetic clutches connect the rheostats and the limit switch during coiling and uncoiling, and simple gravity-type resetting devices are provided.

The electronic unit has a selsyn circuit that provides an output frequency varying with the number of turns (one cycle per count). A 4-stage reversible counting tube system keeps track of these output cycles during coiling and uncoiling, and a sensitive differential relay compares the number of turns with the speed signal obtained from the mill-driven exciters.

First installation is the mechanical unit shown here. It's on a strip mill at Lancashire & Colby Steel Mfg. Co; but both types are to be produced commercially for other applications. —ARG

Mechanical web control incorporates circular rheostat of new design (but built from standard parts), operates at speeds to 1400 rpm, will count to 1600 full turns. Half-turns can also be counted by changing input gear ratio.



New Stanley H270 Heavy Duty Builders Saw, made by Stanley Electric Tools, Division of The Stanley Works, is "built for the professional, priced for everyone." Fafnir-equipped for long, trouble-free service, this big capacity saw offers light weight, power to spare, extra-strong construction, other modern, work-saving features.

STANLEY

New Stanley power saw, Fafnir ball bearing equipped, designed to deliver nearly 40% more cutting force!

Armature, saw shaft, even the blade guard Fafnir-mounted for free-starting, no-maintenance, heavy-duty performance

Nearly 40% more cutting force at working speeds, with 27% less operator effort! This new Stanley power saw represents a design achievement of the first order. And to insure long, efficient service life, Stanley makes generous use of Fafnir precision ball bearings. Even the blade guard is Fafnir-equipped (with an aircraft type bearing), for responsive action at the slightest pressure. On the armature and saw shaft, Fafnir ball bearings all but eliminate friction and wear. Bearing maintenance is eliminated, too. Various combinations of seals and shields lock out contaminants, lock in factory-packed lubricant. No danger of faulty or neglected lubrication... virtually no chance of bearing failure.

Take advantage of Fafnir's "designer's approach" to bearing problems. You'll find Fafnir's breadth of experience and diversity of line insure precise answers. Write The Fafnir Bearing Company, New Britain, Connecticut.

Sealed and shielded Fafnir ball bearings meet specific service requirements in Stanley saws

Felt seal and shield (Motor Armature)

2 Plya-Seals (Blade Guard)

Plya-Seal and shield (Saw Shaft)

FAFNIR BALL BEARINGS

Washington

Price of R & D: $2 Billion in Contract Cancellations

WASHINGTON—As the cost of weaponry for the military climbs, the Pentagon brass has to turn to the chopping axe to stay within the $41-billion budget level clamped on spending. R & D contracts—$2 billion already spent—have been cut and others will undoubtedly be shelved.

Impressive as the R & D cuts are, they don't mean that spending in this area won't continue to be big. Pres Eisenhower asked Congress for a total of some $3.77 billion for military research and development for fiscal 1960. Congress added another $45 million to swell the total to slightly over $3.8 billion, as compared with last year's R & D budget of $2.76 billion (*PE*—Sep 14, p 40).

But even with the increase in funds, the military will still have to shave R & D costs to stay within budget. For one thing, even if no new projects are undertaken, the cost of keeping the present R & D program on its current schedule will increase costs by several hundred million dollars.

On the other hand, the fact that an R & D project gets scratched doesn't mean that money already spent is down the drain.

Cancellation of the Navaho intercontinental missile after some $690 million went into the project is a good example. The rocket booster developed for the Navaho was the prototype of boosters for ballistic missiles such as the Redstone, Thor, Jupiter, and Atlas.

Aerodynamic data developed by the Navaho project has shown up in airframe designs of the X-15, the B-70 and the F-108. Virtually every research project produces valuable results that are spread wide to other projects. This factor is often overlooked when project cancellations are announced. And, it brings forth criticism that millions more have been poured down the drain again.

(*See page 25 for more on R & D contract cancellations.*)

Projects Cancelled	Chief Contractors	Dollars Spent (millions)	Comments
Navaho intercontinental missile (AF)	North American, Curtiss-Wright, Food Mach & Chem Corp, Walter Kidde, Thompson Products	690	Dismissal of some 5000 NAA workers. Project made vulnerable by progress in competing missiles—the earlier but more primitive Snark, the later but higher-performance Atlas ICBM. Navaho propulsion and guidance adapted to other systems.
Seamaster jet seaplane (Navy)	Martin, Pratt & Whitney	400	24 planes ordered initially; cut to 14 last year; 9 delivered by time of cancellation. Martin dismissing 3000 workers.
Rascal air-to-surface missile (AF)	Bell, RCA, Texas Inst, Arma	374	Production was getting underway. More advanced Hound Dog brought rapid obsolesence.
J93-5 Engine and Fuels high-energy boron-based fuels (AF-Navy)	GE, Olin Mathieson, Callery Chemical	240	Work halted on development of GE's J93-5 jet engine; J93-3 substituted in B70 bomber. Two new plants for fuel ordered not to start production. Reason given: reduced requirement for air-breathing engines, and fuel's performance inadequate to justify high costs.
F-107 fighter-bomber aircraft (AF)	North American Aviation	100	Decision made to buy rival F-105 built by Republic; 3 planes built—one now in museum, others used by NASA in flight tests.
Regulus II Surface-to-surface missile (Navy)	Chance Vought, GE, GM's Spark-plug, Texas Inst.	78	Chance Vought laid off at least 1200 because of cancellation. Missile considered obsolete.
Goose surface-to-surface intercontinental decoy missile (AF)	Fairchild Eng. & Airplane, Ramo-Wooldridge, AMF, Paul Omohundro	70	Missile considered obsolete because of low speed.
Dart anti-tank missile (Army)	Utica-Bend Corp, Grand Central Rocket, Bulova, Aerophysics Development Corp, Whittaker Gyroscope	38	Army eventually selected a French-developed anti-tank missile.
F8U-3 all-weather-fighter interceptor (Navy)	Chance Vought	At least 25	3 planes delivered out of 18 ordered for fleet evaluation. Congress ordered Navy to buy one of two high-speed interceptors in development. Nod went to rival McDonnell F4H twin jet, two-man aircraft. F8U-3 was single-jet, one-man plane.
Triton 1200-mi surface-to-surface missile (Navy)	McDonnell, Johns Hopkins Applied Physics Lab, Goodyear Aircraft, Kearfott	24	Ramjet missile like Navaho, pinched by similar problems—project was caught between the earlier, lower-performance Regulus and later, more-advanced Polaris ballistic missile.
Plato mobile anti-missile system (Army)	Sylvania	18	System was to use Zeus missile for field defense against shorter-range ballistic missiles. Army lost control of project to ARPA which decided to halt work.

FLIGHT FORGINGS

BY CAMERON
WHEN DEMANDS ARE CRITICAL

The Cameron split-die forging process has created a new concept in forged components that fly. Parts which must handle new extremes in temperature and mechanical stress are now in routine production at Cameron. As an added benefit interesting economies result from savings in the critical materials, often in short supply, which are specified for these important parts.

Our facilities are complete through every production phase. We melt many of our own special alloys, bloom, forge, heat-treat, and perform machining operations when required. Each of the shapes below was a problem when presented to our Special Products Division. They are now current production items, adding to our ever-increasing list of extreme service solutions.

Forging of a Refractory Throat for Missile
Material: Tantalum 90%
Tungsten 10%
Outside Diameter of Large End: 6.25″
Height: 4″
Outside Diameter of Small End: 5.25″
Weight: 42.25 lbs.

Forging of Turbine Rotor Stub Shaft for Nuclear Jet Engine
Material: A-286 Steel
Outside Diameter of Cone End: 33.687″
Outside Diameter of Shaft: 10.375″
Height: 44.875″
Weight: 1150 lbs.

Forging of a J-93 Front Turbine Shaft for Aircraft Gas Turbine Engine
Material: Waspalloy
Diameter of Conical End: 23.38″
Diameter of Hub End: 6.50″
Length: 27.68″
Weight: 430 lbs.

Forging of a Liner — Exit Cone Missile
Material: Unalloyed Arc Cast Molybdenum
Diameter of Large Conical End: 10.50″
Height: 12.89″
Diameter of Small Conical End: 6.75″
Weight: 104.5 lbs.

If your forging demands are critical, write, call, or come by —

IRON WORKS, INC.
SPECIAL PRODUCTS DIVISION
P. O. Box 1212, Houston, Texas

WHAT'S HAPPENING IN... Science

New metal aids gas studies

Gallium takes the place of mercury in variable-volume gas-compressibility apparatus developed for elevated temperature testing at the US Bureau of Mines; and, D. R. Douslin of its Petroleum Experiment Station told last week's ACS meeting, the "new" metal offers a number of advantages.

The volatility of mercury at elevated temperatures was found to introduce a number of errors to the determination—errors that were not easily corrected. Nonvolatile gallium solves the problem. It does, however, pose problems of its own. It is a costly metal and even its light weight (less than half that of mercury) does not compensate for the price differential (about $2.85/gm for gallium; less than 9¢ for mercury). Furthermore, it shows poor compatibility with other metals. At temperatures above 750 F, columbium, beryllium, tantalum, rhenium, and tungsten can resist attack; though type 347 stainless steel can be used for compressibility cell plugs and inserts if operating temperatures do not go above 400 F.

More "bootstrap" reactors coming

Nuclear reactors that "make" some of their own fuel will have a chance to show their breeding power as AEC breeder reactor development program goes into gear. These breeder or "bootstrap" reactors are designed to use excess neutrons from the original uranium chain reaction to turn nonfissionable thorium into fissionable uranium 233.

Theoretically, a reactor with a thorium blanket could "make" more fuel than it burned, thus even being able to sell the excess. In practice, most reactor designers would gladly settle for a 50% replacement (*PE—Sep 7, p 12*). But AEC hopes at least one of the systems now being investigated will show a "doubling time" of

Gallium-filled P-V-T apparatus is demonstrated here. Compressibility cell is contained in constant temperature bath at left; pressure-transmission equipment is at right. Operator in background handles temperature controls.

25 yr—that is, will create enough excess fuel over a 25-yr period to provide the initial charge for another reactor.

Among the breeder types now being explored (all "thermal" as opposed to "fast" reactors): Liquid Metal Fuel Reactor (LMFR); Aqueous Homogeneous Reactor (AHR); Molten Salt Reactor (MSR).

The new program represents a reorientation of the Fluid Fuel Reactor power-development program, result of an advisory committee finding that it offered little hope for economical power in the near future

brief . . .

Antiparticles are proving that they're "real" by having their pictures taken. U of California's Lawrence Laboratory scientists say three of these strange bits of anti-matter have already sat for their portraits: the anti-proton, the antineutron, and the anti-lambda; and they hope their big new bubble chamber will soon make it possible to "see" the anti-sigma.

(Note: For more on anti-matter, see *PE—July 28 '58, p 10.*)

Conversions that measure

Direct measurement of a physical quantity is a rarity rather than a rule, as K. E. Gould of Bell Telephone Laboratories has pointed out. Electrical measurements, too, are frequently indirect.

Small differences in linear dimensions are often measured by displacement, electrical-capacitor, or optical-interference methods. Electrical strain gages indicate changes in length and weight by changes in electrical resistance; and electrical resistors measure temperature changes.

Indirect measuring devices of this type are actually conversion devices or transducers, and dozens of them are being, or could easily be, put to work.

The Hall effect, (*PE—May 4, p 32*), for instance, is generally thought a means for energy conversion, and it depends on the creation of a voltage differential in the presence of a magnetic field. But it can also measure changes in the imposed magnetic field.

Likewise, the Doppler effect, generally considered a way to tell whether a railroad train is coming or going, may also be used to measure velocity (*PE—Nov 18 '57, p 15*).

Electro-mechanical transducers and piezoelectric crystals, widely used in ultrasonic devices to convert electrical energy into mechanical vibrators, can also be pressed into service to measure linear displacements or pressure changes.

Such low-temperature devices as the cryotron (*PE—Dec 2 '57, p 16*) depend on creation and negation of superconductivity at liquid helium temperatures. Bismuth, for instance, becomes superconductive at temperatures below about 11 K. But imposition of a magnetic field of 100,000 gauss increases its resistance about 24 million times—again, providing a good way to measure the strength of a magnetic field, as well as to create a very efficient on-off electrical device.

—ARG

This one won't shrink or stretch

A fiber, made from cellulose and claiming outstanding dimensional stability—wet or dry—is being introduced by Hartford Fibers. Hartford says it represents a brand-new fiber family, different from both rayon and acetate, and proposes a new generic name, **polynosic**, to describe it. Hartford says the fiber has considerably lower moisture absorption and better alkali resistance than rayon, low elongation, and high elastic recovery.

Production of the fiber apparently involves a basic rearrangement of the cellulose molecule to form large, ordered complexes. The process is one originally developed in Japan and further refined by a group of European manufacturers.

Hartford will import substantial quantities of the material from the European group, until its own plant is ready (about a year from now). It will be marketed under the trade name Zantrel and priced at about 50¢/lb.

(Note: Two other newcomers are described in *PE*—Mar 23, p 7 and Aug 24, p 13; for a rundown of synthetics, see *PE*—Aug 25 '58, p 11; and for a definition of generic terms, see May 18 '59, p 14.)

Ductile ceramics: Another step forward

No one yet has produced ceramics that bend like a pretzel. But researchers at half a dozen laboratories are making discoveries that could pave the way for far less brittle ceramics.

The work is nowhere near commercialization. Researchers are still concentrating their studies on single crystals (*PE*—Dec 9 '57, p 9 and Jan 27 '58, p 14). But new phenomena are being uncovered, and new explanations proposed.

At last week's ACS meeting, for instance, Robert Lad of NASA said recent studies of alkali-halide single crystals show that these materials inherently possess a fair degree of ductility at room temperature, and this can be substantially increased by treatments such as surface dissolution with water, annealing, and surface deposition of a small quantity of silver.

Says Lad: "application of silver by vacuum evaporation on crystallites of sodium chloride, followed by hydrostatic pressing, has yielded a ceramic body possessing a small degree of ductility." This is, however, a specific effect. Other metals, like copper and gold, deposited in the same way, do not appear to increase ductility.

The nature of the surface seems to be the primary factors governing behavior of these crystals, and Lad believes that dislocations caused by cleavage are responsible for the initial inelastic deformation that has been observed. These deformations, he says, can be caused to move by the application of very low stresses.

At the same meeting, E. S. Machlin of the Columbia Univ School of Mines said that rock salt crystals, tested in such diverse environments as mineral oil and liquid nitrogen, showed considerable ductility; while all of those tested in air at normal temperatures showed the usual brittle behavior. Some specimens tested in cold air, though, were surprisingly ductile. His deduction: "The known brittleness of rock salt in air is a function of the ozone or nitrous oxide content of the air, and not the oxygen or neon content." But, he says, tests in oxidizing solutions do show that rock salt is embrittled in the presence of active oxygen.

Magnesia was never like this

High-purity magnesia is making a bid for new electrical and structural jobs, and a look at its properties shows it has quite a bit to offer.

This material, at least 99% pure, has a thermal conductivity at 2250 F of about 5 BTU/hr/ft²/in/°F. Its room temperature dielectric constant at 1 mc is 9.48. At present, only a few producers offer magnesia of this purity. Michigan Chemical is producing 99% material; Carborundum, 99.3; and Norton, 99.4. Corning Glass Works has 99.8% material, and International Minerals claims "the highest purity ever achieved in carload lots": better than 99.9%.

Where can or should this high-purity magnesia be used? One application is in nuclear reactors where its low boron content keeps it from gobbling neutrons. But it has many other applications, ranging from metallurgical crucibles (its melting point is about 5000 F) to thermocouple insulation. Air Force sponsored studies indicate it has good possibilities for use in 930F capacitors. It meets the primary specification of a resistance-capacitor factor greater than 5 megohm-microfarads at that temperature, the most difficult requirement for such ceramics to meet and one, WADC says, that can be achieved only with very high purity materials.

As yet unexplored are possibilities which might be opened up by what appears to be a difference in crystalline structure between "ordinary" and ultrahigh purity magnesia. IM&C says the thermal decomposition and volatilization process it uses to remove impurities "seems to achieve a different crystalline form which is conducive to better electrical properties."

brief . . .

An interesting cushioning material is being offered by Preservation Packaging Inc, Hillside, NJ. It's thin polyethylene sheeting, embossed in the form of small, indented cylinders $\frac{1}{8}$ in. and $\frac{7}{16}$ in. high and about $\frac{3}{8}$ in. and $\frac{5}{8}$ in. in dia (1000/sq ft) to give a density of 1.85 lb/cu ft and a tensile strength of 28½ psi. It's moisture resistant, can be bonded to other paper and film; and is initially to be made in sizes to 18 in. by 25 in., priced at 9¢/sq ft. —ARG

The most dangerous solvents in the world pass through this valve!

But it's a *safe* passage. The ROCKWOOD ¾" (Fig. 802) Self-Closing Ball Valve is designed for *smooth, leakproof* handling of highly flammable liquids. A Rockwood Exclusive!

Take a typical installation at an experimental station of one of the nation's largest chemical companies. Here 36 different solvents, ranging from acetone to xylene, are dispensed from bulk containers. All types of self-closing valves were tried and evaluated for this critical job. None equalled ROCKWOOD for positive performance.

Unique ROCKWOOD Full Round Flow design holds turbulence to an absolute minimum — keeps static at a low level. Flash potential is negligible, greatly reducing fire hazard. In addition, the exclusive "*Spring Pressure* Compensation" keeps ball and seat in snug contact — assures leakproof, dripless shut-off, compensates for wear. Bronze valve body and Teflon trim resist corrosion. After 11 months and 103,200 open-and-shut cycles the company reports: trouble-free operation since installation.

Be as safe and sure with your solvent handling. Send coupon for complete details on the ROCKWOOD Self-Closing Ball Valve. Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
A Division of the Gamewell Company
823 Harlow Street, Worcester 5, Massachusetts

Please send me complete details on the ROCKWOOD ¾" (Fig. 802) Self-Closing Ball Valve.

Name .....
Title .....
Company .....
Street .....
City ..... *Zone* ..... *State* .....

CIRCLE NO. 15 READER SERVICE CARD

CIRCLE NO. 16 READER SERVICE CARD→

Francis E. Blod specifies

Sharonart*

for the kitchen of tomorrow . . .

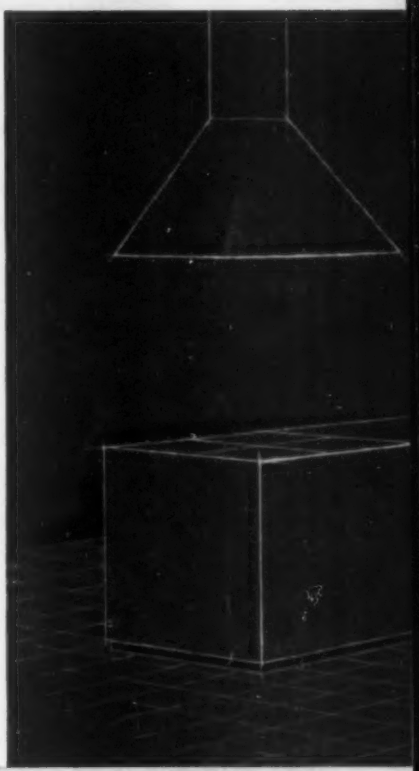
To give kitchen storage added utility and exciting style that blends with modern day kitchen appliances, nationally known industrial designer Francis Blod has taken advantage of Sharonart, to achieve the clean line, functional and highly attractive kitchen storage unit shown on these pages.*

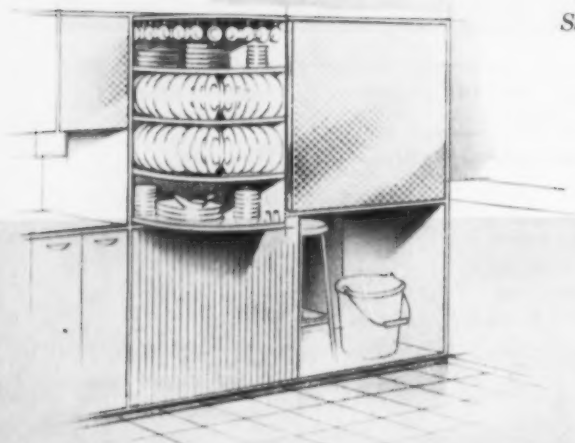
A recipient of many national design awards, Mr. Blod is a Board Member and President Emeritus of the Package Designers Council; graduate and member of the Board of Trustees of the School of Design of Pratt Institute.

Sharonart*, Sharon's exciting new surface patterned steel, is stimulating the imaginations of leading designers everywhere.

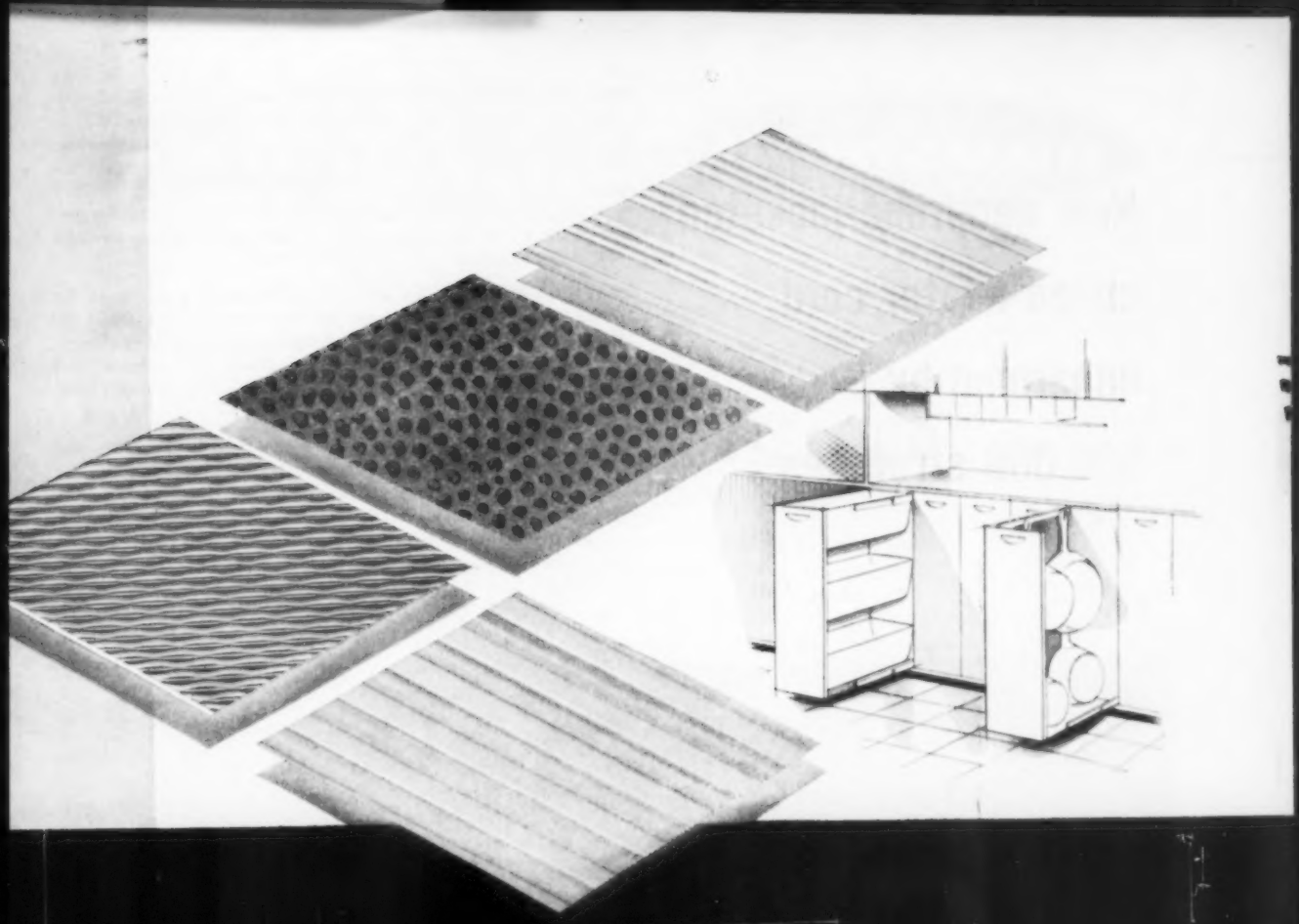
It has all the strength, economy and forming advantages of steel, plus the mar resistance and added beauty of a textured surface. Ideal for wear areas, it permits model changing without retooling. Available in dozens of patterns, Sharonart* can be made in almost any special pattern to suit design requirements. Patterns are rolled in plain carbon steel or in stainless steel. Literature and samples available upon request from the Sharon representative in your area by writing direct to the *Sharon Steel Corporation, Sharon, Pa.*

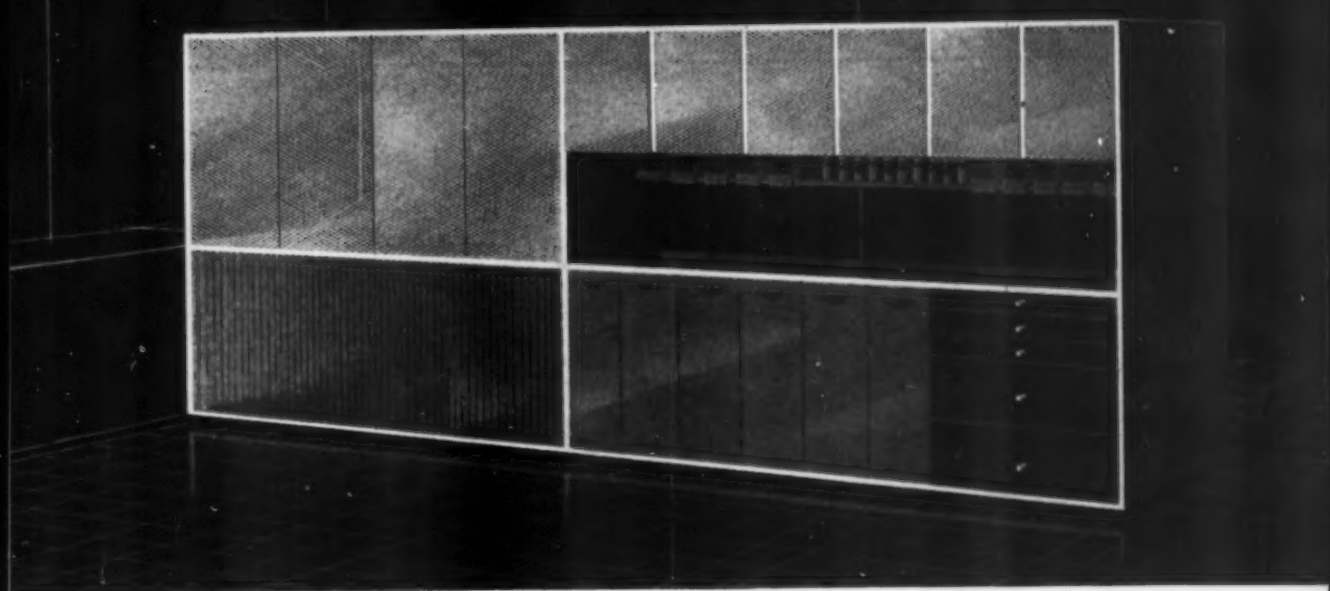
*TM





Rotating cupboard accomodates both dishes and glassware providing organization and ready access while preventing chipping. Sliding Sharonart panel utility section provides storage for outsized objects. Pull-out bins offer ready accessibility to staple vegetables as well as pots and pans. Protruding handles are eliminated through the use of pressure sensitive spring loaded closures and recessed pulls. Trim look of Blod designed kitchen unit includes flatware and linen drawers and automatic Sharonart* stainless steel canisters adjusted to dispense premeasured amounts of dry foods, spices, etc.*





SHARON *Quality* **STEEL** SHARONSTEEL

New neoprene-jacketed coiled heater cord unharmed by 500,000 stretches

This new neoprene-jacketed heater cord was designed with a built-in coil action that eliminates tangling and tripping hazards between small kitchen appliances and connecting outlets. Concerned with the possible ill effects of continued flexing, the manufacturer subjected it to an acceptance test of 500,000 stretch-and-recovery cycles. Following the test, a careful inspection of the flexed sample revealed no damage to the heater cord —no sign of failure in its neoprene jacket.

Long-term flexibility, the subject of this test, is just one of the advantages offered by the neoprene jacket on this new coiled appliance cord. Neoprene also provides good resistance to the harmful effects of heat, food chemicals, cooking oils, greases, and other common household agents that quickly attack ordinary jacketing materials.

Neoprene synthetic rubber, made by Du Pont for 25 years, has become a preferred material in the design and manufacture of many parts used by the appliance industry. Compressible gaskets, oil-resistant seals, flexible boots, durable wire jacketing . . . all benefit from its unmatched combination of important properties. Learn more about neoprene and the Du Pont family of synthetic rubbers. Write to E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. MM-5, Wilmington 98, Del.

Neoprene-jacketed coiled cord (type HPN) can be repeatedly stretched to its full length without affecting spring-back qualities or damaging the neoprene jacket.

DU PONT

Better Things for Better Living . . . *through Chemistry*

SYNTHETIC RUBBER

NEOPRENE
HYPALON®
VITON®
ADIPRENE®

Cord can be used with all hand appliances, is self-storing, keeps work counter area neater and safer. Neoprene jacket resists food chemicals, oils, grease, and heat.

Product Engineering **HORIZONS**

September 21, 1959

tomorrow's HELPER

One of the older–and better–Hollywood stories concerns a down-at-the-heels director who calls on a long-time friend, a wealthy studio executive. The director needs a job desperately. The WSE demurs–nothing coming up at the moment, bankers are hawk-eying, sets a bad precedent, he would be accused of favoritism.

The director hears all this with amazement, then bursts out with: "Didn't I send you train fare to come to Hollywood when you were a starving New York playwright? Didn't I get you your first movie job? And your present job? And introduce you to the wealthy heiress you married?"

Said the WSE, "Yes, I admit you did all that . . . but what have you done for me LATELY?"

This is the hard lesson to learn–that human memory is short and you cannot capitalize today on what you did yesterday, whether it be friendship, work or ideas. Friendship cools, work leaves only reputation, ideas become obsolete. These are history.

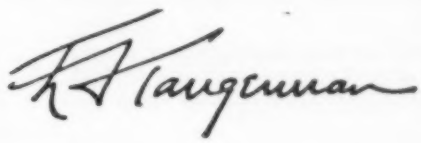
The company without a new product, or with too high a price, is in trouble. Customer confidence is quick to cool, and past performance doesn't guarantee future sales.

The remedies lie with the engineer–in cost cutting and creativity. Cost cutting is based on experience and skill, on knowledge and history. Here accumulated know-how is the answer.

But creativity is an intangible. It cannot even be clearly defined. It often denies or refutes experience, is usually the result of naiveté and curiosity, is likely to be the attribute of youth rather than of age. It is not the product of a committee nor of organization.

Thus the engineer is on the horns of a dilemma, with experience and creativity opposed, yet both required. And meanwhile the management and the purchasing department and the customer all are asking, "What have you done for me *lately*–like today?"

To get an answer, the engineer has to be asking his sources, his men, and himself: "What have you done for me TOMORROW?"



New data on **CAMPCO** *thermoplastic sheet and film*

STYRENES S-540 Styrene—Rubber modified rigid alloy. High impact strength and dimensional stability. Low moisture absorption, good heat resistance. Vacuum form. Gauges .010″ to .187″ stock or custom sheets. Colors, translucent or opaque. For display, toys, trays, packaging, housewares, luggage, housings, cabinets, tote boxes.

S-300 Styrene—Similar to S-540 but with greater rigidity. Good impact strength.

S-1029 Tripolymer Styrene—High impact, tensile and flexural strength at extreme temperatures. Excellent chemical resistance and dimensional stability, low moisture absorption. Forms easily, machines readily. In smooth or Haircell grain finish, gauges .020″ to .125″, many colors. For luggage, housings, chairs, ducts, exhaust hoods, clock cases.

CELLULOSICS A-130 Cellulose Acetate —Strong and tough. Vacuum or pressure form. Machines well. In gauges .003″ to .060″ transparent, translucent, opaque, clear and colors. For blister packs, wraps, displays, toys, novelties, indoor signs.

B-120 Cellulose Butyrate—Exceptional strength in thin sections. Weathers well. Vacuum or pressure form, cut, blank, stamp, stitch, drill, punch. Gauges .003″ to .125″ transparent, translucent and opaque, clear and colors, stock or custom sizes. Easy to decorate by either lacquer or silk-screening. For blister packs, outdoor signs, displays, toys, novelties.

POLYETHYLENE PE-200 Linear Polyethylene — Rigid, tough, heat and chemical resistant with dielectric properties. Forms, machines, welds. Gauges .020″ to .125″ custom sheets and rolls. For housewares, containers, vessels, electrical products, toys, housing, packaging.

PE-100 Low Density Polyethylene — Low melt viscosity, excellent chemical and heat resistance. Stable under humidity changes. Vacuum form. Processes rapidly. In gauges .015 to .125″ gloss finish custom sheets and rolls. For housewares, packaging, toys, containers, form liners, electronic applications.

POLYPROPYLENE PP-300 Polypropylene—Impervious to stress cracking. Excellent dielectric properties, chemical resistance, rigidity, strength. Heat resistant to 300°F. Low specific gravity. Gauges .010 to .250 custom sheets and rolls, variety of colors. For chemical ducts and vats, fittings, electrical parts, sterile items.

NYLON N-106 Nylon — Heat form, machine stamp or die-cut. High melt viscosity, wide molten range. Excellent chemical and abrasive resistance. Self lubricating. Unlimited colors, 20″ to 40″ widths, gauges .005″ to .060″. For washers, grommets, gears, bearings, industrial glazing, packaging, food handling trays.

The range of CAMPCO applications is almost without limit. We would like to work with you in making the best use of these versatile materials. Write or phone today.

NOTE: See the Directory Section for particulars on Chicago Molded's unmatched custom molding services for plastics of all kinds.

CAMPCO SHEET AND FILM
Division of
Chicago Molded Products Corp.
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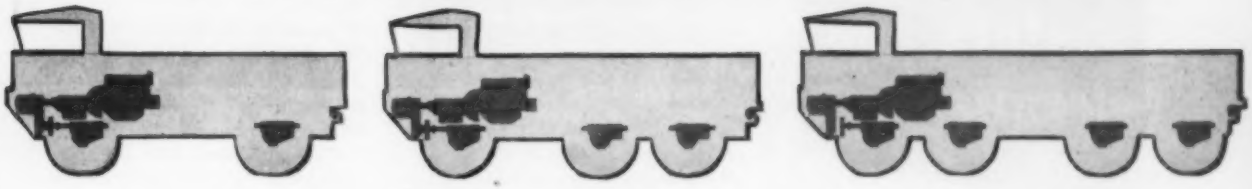
Chicago 36, Illinois



Army's Campaign Underway for Trucks with Interchangeable Parts

New tactics designed to give faster maintenance and smaller stockpiles of vehicle components—4 basic trucks become 12—multi-fuel engines also part of the efficiency-sparking plan.

DETROIT—The push is on to design parts with wide interchangeability into Army trucks of the future. It's to be done by building flexibility into four basic truck series—the light, intermediate, medium and heavy models. Each of them is being further subdivided into three units—small, medium, large—so that the original four actually end up as 12 producible types.

A production contract for one of them, the Mutt, was awarded last June to Ford Motor Co of Dearborn which developed and tested it. Another unit of the same series, also developed by Ford, is now being checked out by the Army. Others are in various stages of planning, development and prototype production.

According to Army sources, maximum interchangeability of parts is expected among members of each of the 4 basic series—and some even among members of different series. It is expected that standard accessory equipment, such as generators, will be applicable in all series.

Previously, commercial truck designs were adapted to military needs—to facilitate maintenance and repair under field conditions, also to reduce inventory of transportation parts in tactical areas. In the new method, designs are developed by commercial truck firms but tailored to military needs. These designs are evaluated, prototypes tested and final design selected. Production contracts are then awarded to one or more firms.

Result: the same truck with substantially the same parts can be produced anywhere. Deviations in minor components will be permitted, but such offbeat parts must be replaceable in the field by standard equipment.

Under the plan, engines, transmissions, transfer cases, axles, wheels, differentials, even elements of the steering mechanism, will be common to all members of a series, but the general plan may be modified as the particular trucks are developed. Such modification, however, is not expected to increase the total number of components, is more likely to result in adaptation of components from one series to trucks of another series: e.g. engine from one series used in lightest vehicle of next series.

Army expects these advantages from new-series trucks: effectiveness for the intended purpose; increase in cross-country, off-road mobility; reduction in spare-parts requirements within the series and within each vehicle.

DESIGN OF A SERIES

A look at the light series, whose programming is most advanced, shows how the plan works. (See above.)

Smallest member is four-wheeled (4x4) and in this series is rated as ¼ ton.

The middle-sized vehicle is six-wheeled (6x6), and substantially the same as the 4x4 but with two wheels and a differential added. This is rated at ¾ ton.

The large member of the series is the 8x8, with two more wheels added to the front, and of course, another differential. Rating will be 1 ton.

The 4x4 and the 6x6 in this series are designed to operate completely submerged, by field addition of an intake and an exhaust venting tube. The 8x8, as well as all members of the higher series, are designed to float. Power for the light series is obtained from a newly designed gasoline engine. Unitized structure is used for the body.

INTERMEDIATE SERIES

This series is designed around a 361-cu in. Chrysler V-8 engine, modified for military use. It will have unitized aluminum structure, automatic transmission, a manually operated 2-speed transfer case, independent torsion bar suspension with snubbers, inboard brakes next to differential, disk type brakes, aluminum wheels with 1400x 18 high flotation tires, and power steering. The 8x8 version is the only prototype being fabricated for test.

MEDIUM SERIES

Competitive development contracts have been awarded to GMC, Ford and White's Reo division, to design and manufacture three prototypes each of the 6x6 and the 8x8 units.

This series will be diesel powered. Prototypes must meet performance, dimensions and weight specifications.

The 6x6 is to be rated at 3½ tons, filling a void in the previous rating progressions.

HEAVY TRUCK SERIES

Redesign of the heavy-duty truck series is awaiting final evaluation of a multi-fuel engine. The hope is for a gas turbine engine that can use any type fuel regardless of where the vehicle is based. Also, the Ordnance Tank Automotive Command (OTAC) wants to cut the number of fuels needed because of future storage and transportation problems.

No one will say what engine is be-

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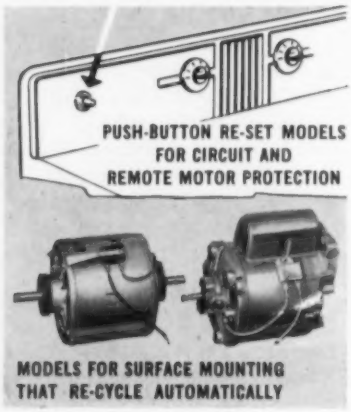
17

appliance makers say it really cuts service problems, **adds sales spark**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MECHANICAL PRODUCTS, Inc.
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ing evaluated, but PRODUCT ENGINEERING's Detroit Editor reports that Allison Div of GM has taken over the GMT 305 turbine engine. GM believes the engine to be out of the laboratory stages and ready for development and marketing. This is Allison's job. At present, Allison has orders for 13 engines; 8 for the military and 5 for commercial ventures.

Breakdown of these orders are: Army engineers, research and development, 2; earthmoving equipment, 1; laboratory dynamometer testing, 1; and 2 each for Bureau of Ships and OTAC. The 5 commercial orders are for over-the-road application, off-the-road application, and three for oil company use.

Allison reports that the prototype price will be $35,000, but in production quantities the engine can be delivered for under $6000. It develops 225 hp, and weighs, without transmission, 650 lb.

ALSO IN THE PICTURE

Last week, Chevrolet showed its new truck line (*PE*—Sep 14, p 39). One truck, not a production model, was operating on a gas turbine engine. Total weight of engine and transmission was given at 1125 lb; total length of package, slightly less than 60 in. Several years ago, Chevrolet exhibited a gas-turbine-powered truck that had an engine and transmission weighing 1472 lb and was 85 in. long.

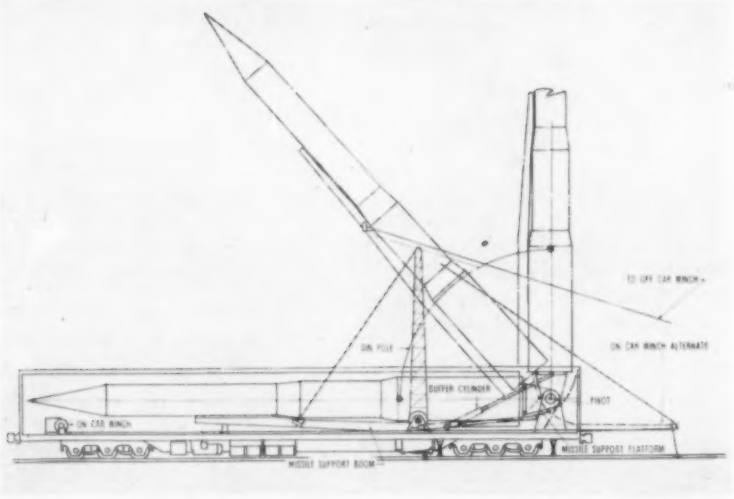
General Motors does not have the gas turbine field to itself. It is known, for example, that OTAC has been evaluating for over six months a Chrysler gas turbine engine.

Also, last April, Ford Motor Co showed its new 704 gas turbine to the military. This engine's 2-stage air compressor makes it possible to deliver more hp from smaller sizes. A special feature is the max fuel economy obtained at less than 100% of power.

Engine weighs 650 lb installed; is 38 in. long, 29 in. wide, 28 in. high; is rated at 300 hp; and is expected to go into trucks, heavy-duty tractors and bulldozers, and other off-the-road equipment. It is also applicable for stand-by power and jet engine starting.

Ford says the 704 does not require special preheating cycle and will start cold in all normal temperatures. It will use unleaded gas, kerosene, jet engine fuel, or light diesel fuel. ■

A Maybe Mobile Missile-launching System



Gin pole concept, developed by ACF Industries, Inc, and AMF Co, is applied, in theory, to their mobile missile launcher. Missile support boom and platform are pivoted at the trunnion located 10 ft above floor level. Gin pole, pivoted about 20 ft forward of the trunnion carries the cable over a sheave at the top. Cable elevates the missile-carrying boom by pulling at a point about 40 ft from the trunnion. With the winch located in the launcher car, a second gin pole is required, extending horizontally out the rear of the car at floor level. Gin pole and cable place missile and boom in a diagonal position where cable pull alone can finish the lifting job.

Industry Spends Most R&D Money on Aircraft

WASHINGTON—Two industries (aircraft and electrical equipment) accounted for slightly more than half the $7.2 billion spent on research and development by private industrial firms during 1957.

Other gleanings from the survey, conducted for the National Science Foundation by the US Bureau of Census, are contained in a preliminary report entitled, "Funds for Research and Development Performance in American Industry, 1957, Reviews of Data on Research and Development."

Total R & D performance in private industry, as reported by the survey, increased about one/fifth from 1956. Some $3.7 billion was financed in '57 by the federal government. Most of these federal funds were concentrated in the aircraft and parts industry which accounted for almost three-fifths of the $3.7 billion.

Funds for basic research by private industrial firms totaled $241 million during 1957—just 3% of total research expenditures. Slightly more than half the amount spent for basic research was devoted to the physics and mathematical sciences, with an additional one-third going to engineering sciences and the remainder to life science.

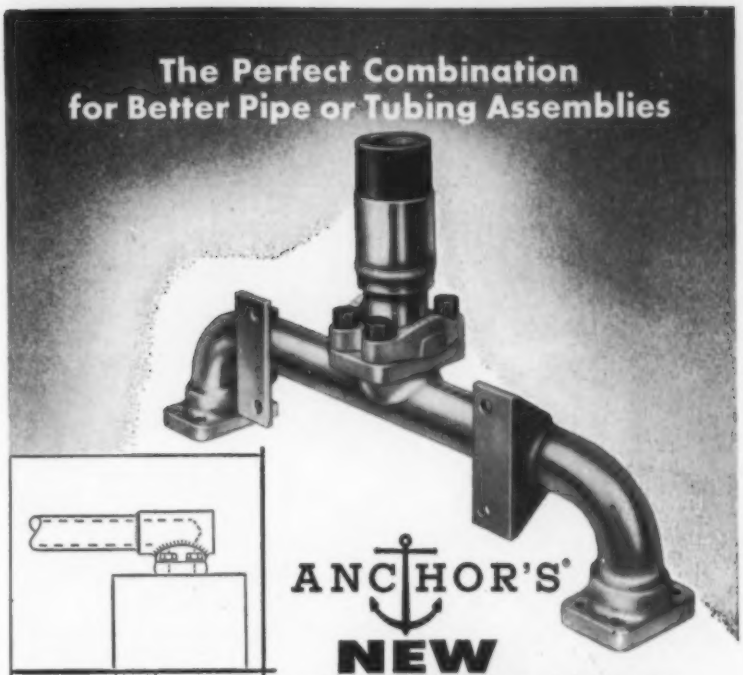
Although such surveys have been made for NSF since 1953, figures reported are based on varying survey procedures; hence, no consistent trend data can be offered. However, for overall comparisons, total industrial R & D performance is estimated as follows: 1953, $3.4 billion; 1954, $3.8; 1955, $4.3 billion; 1956, $6 billion; 1957, $7.2 billion. ■

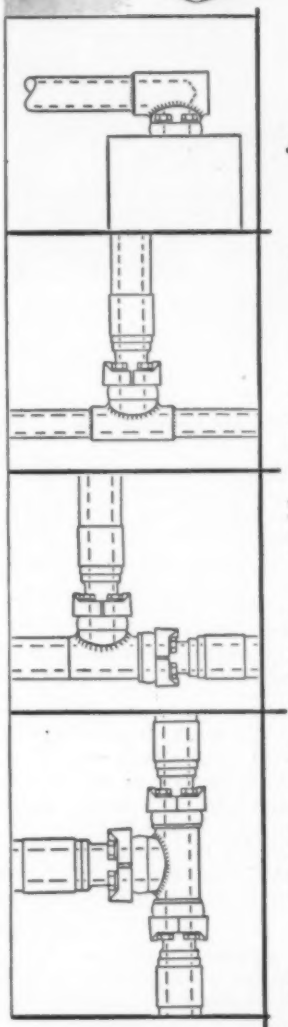
US Engineers Eligible for 'Medal of Science'

WASHINGTON—Some 20 engineers and scientists who achieve outstanding success in research or development will be honored each year with a "National Medal of Science."

A bill providing the awards in the engineering, physical, biological and mathematical sciences has been signed by the President. Nominees will be recommended to the President by the

The Perfect Combination for Better Pipe or Tubing Assemblies





ANCHOR'S

NEW

WELD TYPE FITTINGS

for use with Anchor Flanco Couplings

Anchor's new Weld Type Fittings, when combined with FLANCO Split-Flange Clamp Halves and "O" Ring Flanged Head Couplings offer new flexibility and versatility in the use of pipe or tubing in hydraulic transmission lines. By using them, pipe threads and pipe f tings with all the piping problems they present, can be eliminated, and pipe or tubing assemblies with better flow characteristics can be produced.

Four cap screws are used to bolt these new forged steel weld type fittings to flange or port. An "O" Ring ensures a leakproof connection. Fittings are available with drilled holes and "O" Ring Groove for bolting to valve or pump, or threaded holes without "O" Ring Groove for connection to Anchor FLANCO Hose Assemblies by means of Anchor SAE 4-Bolt Split-Flange Clamps.

Anchor's new weld type fittings are designed in straight, 90° elbow and tee styles for the ends of pipe or tubing, and in saddle style for welding onto pipe or tubing between the ends. With the saddle style fittings, any number may be placed along the length of the assembly.

Andy Anchor says:

My new Weld Type Fittings plus FLANCO Split-Flange Clamps and "O" Ring Flanged Head Couplings can't be beat for pipe or tubing assemblies. Write today for data sheet giving complete details and specifications.

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This miniature thermostat, a new product of Stevens Manufacturing Company, Inc., is a snap-acting unit to open on temperature rise, especially valuable for missile, avionic, electronic and similar uses. Available in semi-enclosed and hermetically sealed types, it fills the need for a reliable thermostat that is both snap-acting and has a narrow differential for close temperature control. Its metal case provides excellent heat transfer to the bimetal, principally because of the minimum mass of the cover and case, altho the disc element is not mounted against the case itself. Each thermostat is *individually* calibrated, regardless of quantity. Temperature range is 10° to 260°F, 2° to 6°F differential. Available with one or both terminals grounded. Rating is 1 to 3 amps, 115 VAC and 28 VAC/DC.

Here we get into the highest type of precision temperature control, applied to electronic equipment which is not only worth, in some cases, over $1000 per pound but which affects the functioning of the complex machine or missile in which it is installed. Stevens has operated such controls from a million to a million and a half cycles with little or no change in temperature. We're proud that Chace Thermostatic Bimetal has what it takes to provide such complete reliability and accurate response under critical conditions. Only experience such as our third of a century as manufacturers of bimetal exclusively can offer such security.

When your new temperature responsive device approaches the design stage remember that Chace Thermostatic Bimetal is available in strip, coil or completely fabricated and assembled elements of your design. Send for "Successful Applications of Chace Thermostatic Bimetal," containing many pages of design data.

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National Academy of Science.

The medals are the brainchild of Rep Victor Anfuso (D-NY) who proposed it as a way to provide stronger incentives and prestige in scientific endeavor. He had originally urged that tax-free cash awards as high as $10,000 be made, but relented when a colleague objected. ■

College Board Exams Are Being Replaced

Iowa City, Iowa—A "less-expensive, more comprehensive" testing program for college-bound highschool seniors was announced today by the Univ of Iowa. It marks the first real challenge to the long-established, but often criticized college entrance examination board (CEEB).

Here is a comparison of the two systems:

College boards charge each highschool student $6 for a scholastic aptitude test (until this year it was $7). The student's highschool is also charged 10 cents for each test given. A further test, to determine advance placement, costs the student another $9.

Iowa's American College Testing (ACT) program will charge each student $3, and levy no charge against the highschool. The Iowa test covers both scholastic aptitude and advance placement. It is also designed to provide guidelines for student counselors and serve as basis for granting of scholarships and loans.

CEEB provides the participating colleges with only two scores—mathematics, and one which reflects word knowledge and reading ability. No reports are made to the student or the high school.

The Iowa program will give the colleges four scores–English, mathematics, science and social studies. It will also tell the student his score in an interpretive leaflet, and report the score to the highschool. When the students become college freshmen, their college grades will be reported back to high schools, to help these schools judge their own teaching programs.

ACT will get under way in November with between 200 and 300 participating colleges and universities. Like the older program, it will help the

colleges determine in advance which students are qualified for admission.

The CEEB tests, popularly known as the "College Boards," are administered for about 200 colleges, with less than 20% of the nation's total college enrollment. CEEB was established in 1901, primarily for Ivy League schools, and has had the field to itself.

Dr E. F. Lindquist, director of the Iowa program, sees in the new testing program the only salvation for some colleges where entering students now have to take up to 18 hours of tests the first week they are on the campus. This is bad enough now, he says, and will be vastly worse when the number of college freshmen jumps from 711,000 this year to an estimated 1,267,000 in 1969.

Even so, Lindquist said he did not expect many schools now using the college boards to drop them. ■

Here's Why Pentagon's Cutting Contracts

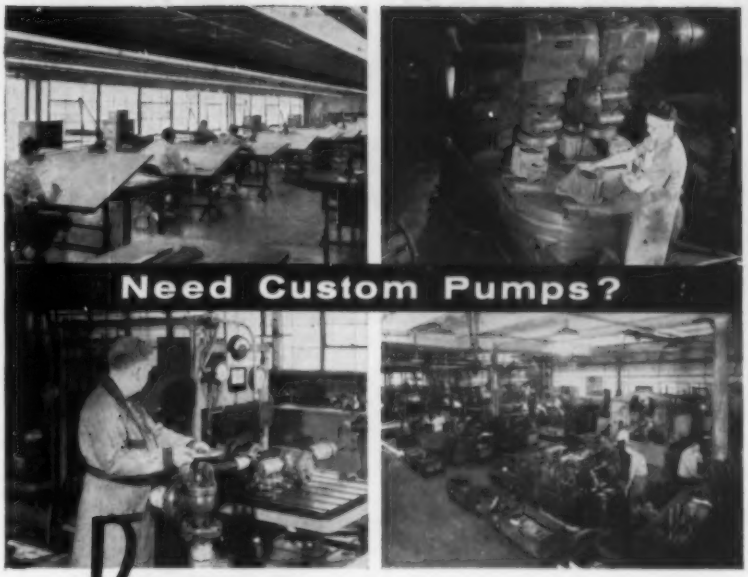
WASHINGTON—Alarmed by the extent of R & D contract cancellations made by Pentagon brass (see Page 11, *this* issue), engineers are turning their attention to the whys and wherefores of such budget slashing.

The reason for dropping projects after millions have already been spent to develop them stems from a mixture of technical and budgetary reasons. The dollar lid is obviously the primary factor involved. But because of it, the military is forced to do a weeding job on all its projects.

It becomes a matter of deciding which of several programs underway shows the most promise. Defense Secy McElroy has made it plain that competition for the defense dollar is going to get keener in the months and years ahead. Programs that are marginal in value can look to be cut at any time. Weaponry improvements must be substantial and not just slightly better than existing equipment if they are to be supported.

Part of the reason for dropping existing R & D projects is to make way for new programs. Technological advances, too, eliminate the need for programs. In some cases, this is only a long-range promise, but it often is sufficient to scratch an intermediate project.

Progress being made with missiles



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Here, at Roper, we sometimes get the comment: "We need a pump of a custom nature, but it appears we can produce it ourselves."

While we do not quarrel with the theory that a do-it-yourself project *may lead* to results wanted, we often question if such results are commensurate with the price paid in time, effort and capital expenditure. We prefer to think that our plant and our staff can produce custom pumps that *will* fill the bill — and at *appreciable savings* to the customer. We feel this way because Roper has specialized in manufacturing pumps for over a century, and has the up-to-date know-how and facilities to cope with any pumping problem.

If you are currently working on either high or low pressure systems . . . if size and weight are determining factors . . . if time and money are of great importance, then direct your inquiry to Roper for valuable assistance and dependable pumps. May we roll up our sleeves to help you?

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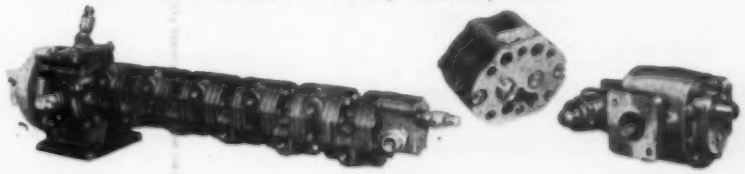
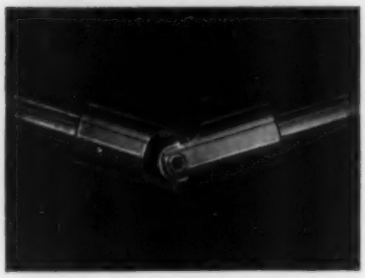
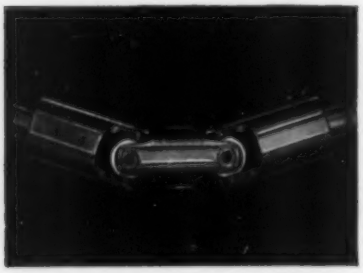


CIRCLE NO. 25 READER SERVICE CARD

How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

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because our catalog torque and load ratings are substantiated by constant tests under production conditions.

14 SIZES ALWAYS IN STOCK —
⅜" to 4" O.D. (6" joints on special order)

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is a good example. The prospect of having the 5,000-mi ICBM Atlas and Titan missiles operational soon is forcing new decisions on some of the long-range bombers designed as intermediate weapons. The B-70 bomber is one example. Recently the program to have this bomber use boron-base fuels with a special engine was dropped by the Pentagon after some $240 million was spent developing these fuels and their engine.

There is speculation, too, that this foreshadows dropping the entire B-70 program being developed by North American Aviation Co. The big B-70 is designed to fly at Mach 3 speeds above 70,000 ft, but won't be operational before around 1964. And it will take additional millions to get the first bomber in the air. Even then, Defense Secy McElroy says, it would cost $5 billion to $10 billion to produce a worthwhile number of the planes. Atlas missiles sell for around $2 million each. ■

Too Few Girl Grads Enter Tech Fields

WASHINGTON—Of 88,000 women graduates from the college class of 1957 throughout the US, some 42,000 accepted jobs as teachers while only 4.6%, or 3948 of the distaff graduates, entered the physical, biological and engineering sciences.

A survey conducted by the Women's Bureau of the Dept of Labor showed that 586 women got jobs as chemists, that 703 were employed as mathematicians and statisticians, and that 2464 went to work as "technicians, biological." Only a small percentage had gone on to graduate work.

Upshot of the survey, according to Jean A. Wells of the Women's Bureau, is that women still aren't aware of the expanding opportunities in the scientific professions. The report entitled, "First Jobs for College Women," urges proper counseling for young women if they are to fulfill their personal goals, and also be of maximum service to society.

A comparison of salaries by occupation shows that girls who went to work as chemists started at an average salary of $4847; mathematicians started at $4675; biological technicians got $3854. Over-all annual average was $3739, up $598 since 1955. ■

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REPRESENTATIVES IN ALL PRINCIPAL CITIES

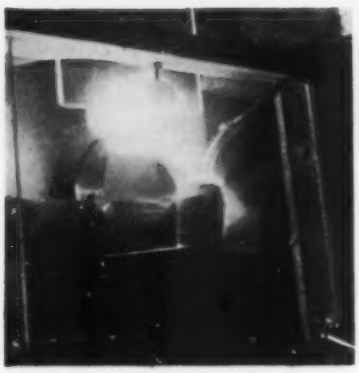
Egypt Expects 5-year Famine of Engineers

BEIRUT—Egypt is expected to suffer a shortage of engineers for at least five more years. This is the studied opinion of the Egyptian Commission on Engineering Mobilization.

While high schools are graduating more students into Cairo and Alexandria engineering colleges, the Commission reports that some 1650 engineer graduates were needed this year in Egypt, and that there were only 598 available.

A partial breakdown shows that there were 102 mechanical-engineer graduates, and 562 needed; that there were 144 electrical-engineer graduates, and 376 needed; there were 18 chemical-engineer graduates while 81 were needed; but there was one optimistic note—a total of 8 aeronautical engineers received diplomas, and the announced need was for only 9. ■

Man-made Lightning for Metal-forming



"Spark bomb" created by Republic Aviation engineers triggers an underwater explosion that bulges an aluminum tube. Experimental device sets off an explosion by passing electricity through the water, converting the resulting shock wave into the force required to form metals, especially high-strength metals for aircraft and spacecraft presently formed in motor-operated hydraulic press equipment. Electrical energy is stored and released in 40 millionth of a sec with a rate of 6000 hp. In operation, electric power is fed into a battery of capacitors. Wires from the plus and minus terminals of the capacitors are attached to two electrodes immersed in water. When a discharge switch is released, the resulting spark travels through the water at extremely high velocity, creating a shock wave.

NEW HAMPSHIRE BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.

NEW TECHNIQUES SOLVE SHIELDING AND IDENTIFICATION PROBLEMS

For some time, now, the precision instrument bearing industry has been searching for the solutions to two problems: (1) *how to develop a more effective shield;* (2) *how to provide visual identification for parts as small and precise as instrument bearings.* Exhaustive research in both areas has finally borne fruit for New Hampshire Ball Bearings, Inc. Both problems have been solved. The solutions seem so simple that it's surprising they weren't discovered long ago.

MORE EFFECTIVE SHIELD

What a big difference a slight change from traditional design can make! By eliminating the recess in the inner ring, New Hampshire's design engineers have reduced by more than 70% the size of the dirt particles that can get into the bearings.

The primary function of a shield is to keep dirt out of the bearing. A contact seal between the two rings wouldn't do. It would increase torque and cause wear. The rings must be able to turn independently. So, the idea is to close the gap as nearly as practicable.

Fig. 1

Fig. 2

The conventional answer, (Fig. 1), inherited from large bearings, falls down badly. Because the recess has to be machined instead of accurately ground, the gap between shield and recessed surface is as high as .007", while that between shield and shoulder is even higher. This means that dirt particles as large as .007" can get in. With large bearings this is not too serious a problem. But with some of the small bearings, such particles are ¼ as large as the ball. That creates a serious torque and wear problem.

Defenders of the old design argue that the recess creates a "labyrinth" effect that discourages entry of large particles. New Hampshire designers maintain, however, that a smaller gap is the more effective answer.

New Hampshire's design, *(Fig. 2)*, closes the gap to .002" or less than ⅛ that of the old design. This close tolerance is made possible by fitting the shield to the precision ground O.D. of the inner rings. This simplified design has no corner where dirt and dust can collect to cause drag between shield and ring. It also provides a broader reference surface for the mounting.

VISUAL IDENTIFICATION

A new marking system, recently introduced by New Hampshire Ball Bearings, Inc. gives you three important pieces of information at a glance. When you see the marks, you know that the instrument bearings are made by New Hampshire . . . that you are getting ABEC 7 tolerances or better at no extra cost . . . whether they're made of stainless steel or chrome steel.

Here's the code. Sets of double lines 120° apart indicate Stainless Steel, *(Fig. 3)* . . . 180° apart, Chrome Steel, *(Fig. 4)*. Such visual identification assures correct deliveries by New Hampshire, correct application by you.

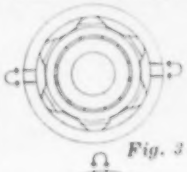


Fig. 3

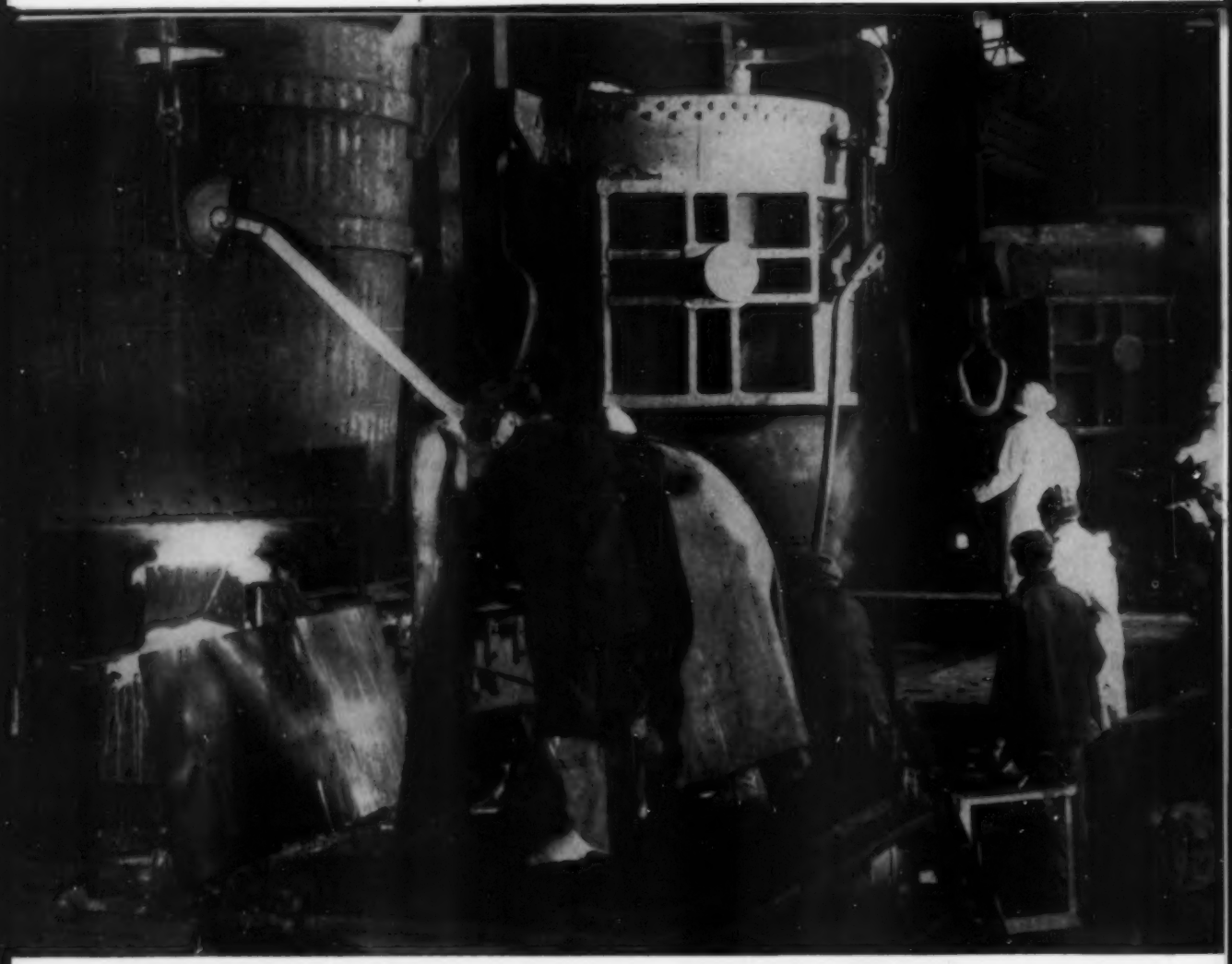
Fig. 4

Notice that the marks are applied to one face of the outer ring where research proves there can be no detrimental effect on performance, mounting characteristics or bearing life. Marks are applied by impact before grinding and heat treating. They cause no dimensional change, distortion or destructive effect on finish.

HANDBOOK FREE TO ENGINEERS

This authoritative, 80-page handbook contains everything you need to know to help you incorporate miniature ball bearings in instruments and electro-mechanical assemblies. It will be sent free to qualified engineers, draftsmen and purchasing agents.

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH, N. H.



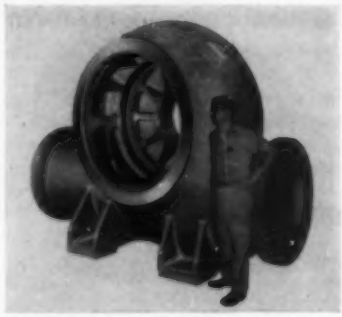
Specification steel making in Blaw-Knox Steel Foundries gives your product physical properties for maximum service

To insure the physical properties necessary for the service requirements of your product, Blaw-Knox maintains facilities for specification steelmaking including the regularly used mixes of carbon steels as well as special alloys such as molybdenum, chrome, nickel, and vanadium grades.

Ten acid open hearths, ranging in capacity from 10 to 70 tons, and two electric furnaces are available to produce exact quantities of many different grades of steel for many different castings at the same time. In some cases, as shown, huge castings weighing up to 300,000 pounds are poured simultaneously from three ladles.

Steelmaking to your order, in large or small amounts, is another part of Blaw-Knox Steel Casting Service that adds value to your product. And there's good reason why. Blaw-Knox, one of the world's leading manufacturers of rolling mills and industrial machines, knows how to keep an eye on the end-use conditions of a steel casting, make it for maximum service.

If you design or build products using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like you to have a copy of our brochure detailing Blaw-Knox Steel Castings Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.



This intricate pipe line booster compressor housing was cast and machined at a Blaw-Knox Foundry. Test pressure 1800 p.s.i.—working pressure—1500 p.s.i. Weight—20,000 pounds.

BLAW-KNOX **STEEL CASTING SERVICE**

CIRCLE NO. 28 READER SERVICE CARD

8 *steps to better engineering writing...*

1. . VANITY AND LAZINESS, BE SIMPLE
2. . BE POSITIVE, BE BRAVE
3. . BE PERSONAL, BE SPECIFIC
4. . BE CONCISE, DON'T OVERSTATE
5. . VOCABULARY, GRAMMAR, PUNCTUATION
6. . TABLES, FIGURES, CAPTIONS
7. . WHERE TO PUT WHAT
8. . SIT DOWN AND WRITE

RICHARD M. KOFF, *senior associate editor*

Lesson . . 3

Most of us have been taught in grade school never to begin a paragraph with "I," that it's probably wise never to use that personal pronoun at all. Engineers and scientists have that lesson reinforced in their college years by instruction in the "scientific method" in which objective truth is supposed to be its own best salesman – the colder and harder the better.

Once out of school and faced with some of the market-place atmosphere of industry, we realize that objective truth by itself has only a very small voice to attract the attention of a distracted reader. The argument here is not with "truth," but with excessive objectivity, which freezes all the humanity and interest out of most technical writing.

The man who writes for a larger public, even those who are engineers and scientists, know better. Thor Heyerdahl, archeologist and explorer, starts his best-selling book:

> "I had no *aku-aku*.
> "Nor did I know what an *aku-aku* was, so I could hardly have used one if I had had it."

These sentences couldn't be more personal and it's almost impossible to stop reading the book once you start.

They also demonstrate a second, related rule: Be specific. It would be far more logical for Heyerdahl to start with generalities. What were his theories, how were they formed? Instead you are told about an *aku-aku*. No definition of terms, no generalities, but a very specific thing which you are curious to know more about.

To be specific means to talk about trees, not forests; murder and arson and theft, not crime; valves and pumps and reservoirs, not hydraulics; steam and boilers and turbines, not thermodynamics. Steam and turbines make pictures in your reader's mind while thermodynamics is the name of the only course he nearly flunked.

HOW TO BE YOURSELF

At first it will seem difficult, immodest even, to inject yourself into a letter or report. The temptation to generalize (and pontificate) will be almost irresistible. But to the reader the personal note will not seem immodest and the specific reference will add drama. For example, here is a memo written by an engineer to his immediate superior:

> This is in reference to Engineering Department equipment and the efficiency thereof. In general, the newest additions have been behaving reasonably well. A ballistics problem awaiting solution for some time has finally been solved. The Structures Department has also been making good use of the equipment. However, there are still certain mechanical and design difficulties to be ironed out. The Human Engineering aspects need some attention to make the unit easier to operate and control. The input-output devices have caused certain delays in handling. Maintenance and repair work will be required . . .

But it also could have been written

> You asked for my opinions about the new engineering department computer. Well, we've had pretty good results so far. The trajectory integration problem was solved in 15 minutes. The structures men are happy as clams now that the iterative strut has been programmed. But there are still some bugs. The signal lights occasionally start flashing like a pinball machine, and they really panic you if you've never seen it before. The tape reader jammed last Tuesday and spilled a couple of thousand feet of tape into the control cubby. It took us an hour to clear a path to Sam Jarvis who was running his stress-analysis problem at the time . . .

NOW YOU TRY

Here is a paragraph from the introductory chapter of a well-known engineering reference text. Use a little imagination–place yourself in the shoes of the author for a moment–and try writing the paragraph more personally and more specifically to give it some life and interest. Our version (by no means the only one, or the best) appears below.

> Before a new idea or process in any branch of engineering or natural science can be utilized, it must be embodied in a suitable physical form. For this reason, a knowledge of the principles of mechanical design is a necessary part of an engineer's training, even though the student may not expect to become a professional designer . . .

Engineering is hardware–screws and nuts and bolts, castings and resistors, pilot lights, bearings, gears and IC engines. No matter how theoretical your research, no matter how high up the ivory tower you'd like to work, you must be able to make airplanes out of aerodynamics, radios and TV sets out of solid-state physics.

***Reprints** of this series will be available at the end of October. To reserve your copy, Circle P15 on the Readers Service Card.*

Proceed- OPERATION EXPANSION

September 1, 1959 — Raytheon Government Equipment Division today announced a major expansion into five operating subdivisions: Submarine Signal, Airborne Electronic, Systems Management, Heavy Electronic, and Santa Barbara.

Made necessary by expanding product activity, the decentralization has created managerial and technical staff positions in all areas.

Engineers and scientists of established technical competence are invited to investigate the several opportunities present in the area encompassing their particular interest.

Inquiries should be forwarded to Mr. Donald Sweet, Engineering and Executive Placement, Government Equipment Division, Raytheon Company, 624J Worcester Road, Framingham, Mass.

H. R. OLDFIELD, JR.
Vice President & General Manager
Government Equipment Division

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SYSTEMS MANAGEMENT

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Harold M. Hart,
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HEAVY ELECTRONIC EQUIPMENT

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can we get

MORE ENGINEERING PER ENGINEER?

Our civilization is becoming more complex at an exponential rate—much too fast for the supply of engineers to keep up. Here is a view of new techniques and equipment designed to reduce the noncreative load on engineers.

HARRY H GOODE *technical director*
Systems Division, Bendix Aviation Corp, Ann Arbor, Mich

■ Society is calling for more engineered products in no uncertain terms. A comparison of US population growth with speed of transportation, communication, and the number of working engineers, shows this trend clearly. While population has trebled since 1890, the speed of transportation (one measure of technical progress) has gone from 60 mph to over 18,000 mph (in satellites)—an increase of 300 times. Telephones in use increased from a few thousand (if you accept telegraph as a reasonable substitute) to over 60,000,000!

In the same time interval, the number of engineers has multiplied some 25 times, a very substantial increase it's true, but an increase that appears to have brought us close to the saturation point. We are already devoting more than three out of every 1000 people to engineering. It is hard to see how a society can afford much greater fractions in the engineering profession without becoming completely lopsided. Moreover, it is questionable whether a greater fraction can become useful engineers.

Therefore, to maintain its current rate of progress society is demanding more efficient use of the engineering man-hour, that is, more engineering per engineer.

What does the engineer now do?

On the facing page you find a list of the tasks which make up the engineer's job. Their order is not important and the percentage of time spent in each task will range widely for each engineer. But a significant portion of his time is spent on the routine tasks in the group.

I submit that if we are to get more engineering per engineering hour, we must reduce time spent in tasks at the left of this list—those portions of the engineer's job which are not creative in the engineering sense.

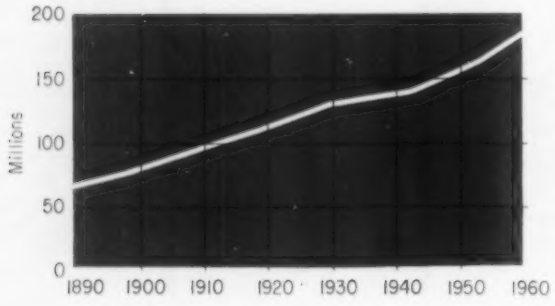
The engineer himself, either through habit or through natural inclination, tends to emphasize the routine portions of his job at the expense of the creative portions. He is encouraged to blow up those aspects of his job which are routine and discouraged from creativity and planning activity. In industry the starting engineer is pegged in a job about as routine as one can get. In practically every branch—mechanical, electrical, civil—he is either put on the drafting board or into operations. After two to three years in this work, he enters upon the main engineering task—which he now conceives of as a set of routines. By the time he is an engineering manager, it is difficult for him to conceive of the engineering task carried out in any other fashion.

To handle the routine . . . new methods

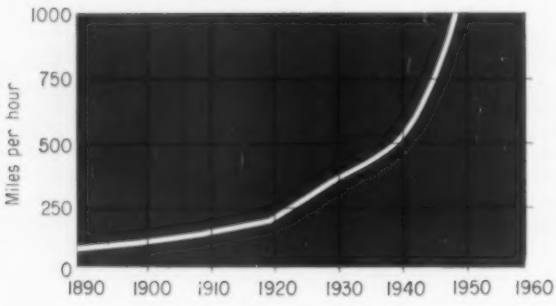
The past 15 years has seen a revolution in tools and equipment to replace the "standard" method of doing things. Here is a brief review of what is available:

Linear programming is a technique for optimum selection of variables in a many-variable problem. (*PE*—Oct 14 '57, *p* 93; Mar 3 '58, *p* 55; May 11 '59, *p* 84). Chemical engineers have applied it in gasoline blending. Transportation engineers have encountered it in routing problems. Communication engineers have analyzed for message traffic allowable over various types of communication facilities. Where it applies to parts of an engineer's job it will make deep inroads into the scheduling and costing aspects and may aid in the administrative planning function.

U S Population



Speed of Transportation



Queueing theory (*PE*—Nov '55, p 188) solves for the number of channels of flow necessary for a given job, amounts of traffic which can be handled, waiting times, the rates at which equipment will deteriorate. It aids in analysis and in decision-making on technical questions.

Human factors research fits machine to man (*PE*—Dec 30 '57, p 34; Mar 31 '58, p 97). It concerns itself with three major questions: What shape and form should equipment take to best match human beings? How does a human best fit into a system and which of his functions is best suited to mechanization (whether from an administrative or a design standpoint)? How can we best train humans to do the job that they will have to do in our highly mechanized lives? The engineer's job will be affected by the results in this area in two ways: He will be aided in finding solutions for design problems; administratively, it will affect how his assistants will be used.

Decision theory (*PE*—Dec 2 '57, p 36; Apr 6 '59, p 35; Sep 23 '57, p 35) will have a more far-reaching effect than the others. It operates by drawing into a situation all of the essential elements in the making of the decision itself. This view of the decision-making problem has had great impact in the communications area in systems planning.

Information theory (*PE*—May 4 '59, p 32) allows us to estimate the amount of information contained in language, the amount flowing through a channel of communication, and the amount taken in by receptors, as for example, human eyes or radar. While information theory will have far-reaching effects on the entire engineering job, it will affect the library research function more directly.

. . . and new equipment

Foremost is the high-speed digital computer (*PE*—Sep 9 '57, p 40; Jun 2 '58, p 28; Jan 26 '59, p 28) which has so affected every aspect of today's living. The computer has, in addition to revolutionizing the execution of various routine tasks, forced a reconsideration of methods for doing the tasks. The computer will directly affect scheduling, costing, library research, analysis, decision making and judgment, as well as paper administration.

Other equipment, used as components along with computers, have been applied to advantage elsewhere. High speed communication nets, for example, are major contributors. Not only can one person in an organization talk rapidly to another, but one computer in an organization will be able to talk rapidly to another computer in the same organization, or in others. This will directly affect library research, paper administration, and of course, indirectly, many of the other familiar engineering tasks.

How the engineer spends his time

Scheduling	Report Reading
Costing	Supervision of Others
Library Research	
	Ingenuity
Analysis	Administrative Planning
Judgment	Technical Planning
Decision	Report Writing
	Selling
Technical Work	
Administrative Paper	Recreation
Administrative Meetings	

A computer contains a large memory. We are getting to memories of the order of 10^9 to 10^{10} words. Such large memories have a tremendous effect in costing, in library research, in paper administration, and in reporting.

Input and output equipment, the high-speed printer for example, is capable of exhibiting a tremendous amount of information in a short time. Oscilloscope display makes it possible to show engineering curves immediately, thus cutting time for analysis by factors of a hundred. Original data are being computed on machines and inserted into the data-processing system directly. Finally, devices capable of fast reproduction of information records, whether drawings, written material, or calculations, will act as a lubricant for all of the engineering functions.

Effects of the new tools

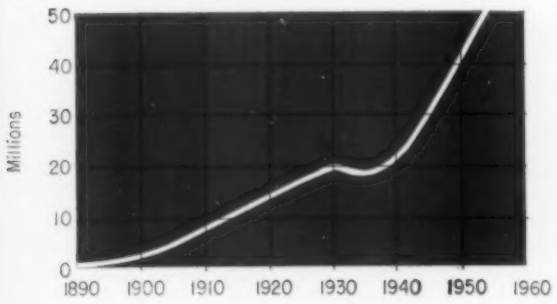
Clearly, if routine engineering can be reduced or eliminated there is more time for higher engineering functions. These tools can help.

Whether the engineer actually would apply the freed time to more creativity, or whether he needs routine work to ruminate over the problem, is still open to question.

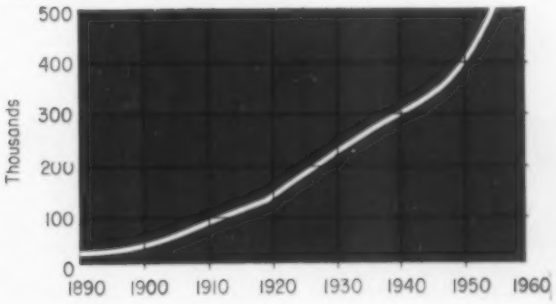
We don't know, but surely it's worth a try. I don't think we can doubt that creativity is affected by the conditions surrounding it. Individuals report their own greater creativity under one set of circumstances as opposed to another (*PE*—Aug 24 '59, p 20). If this is true, then changing the conditions of the engineering job will increase everybody's creativity somewhat, leading to a greater yield of engineering per engineer.

EDITOR'S NOTE: This article is based on a paper delivered by the author at the 7th Annual Engineering Management Conference in Los Angeles last week. Reprints of the article are available. Circle No. P6 on the Reader Service card.

Number of Telephones



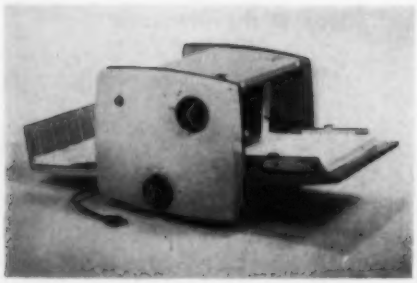
Number of Engineers

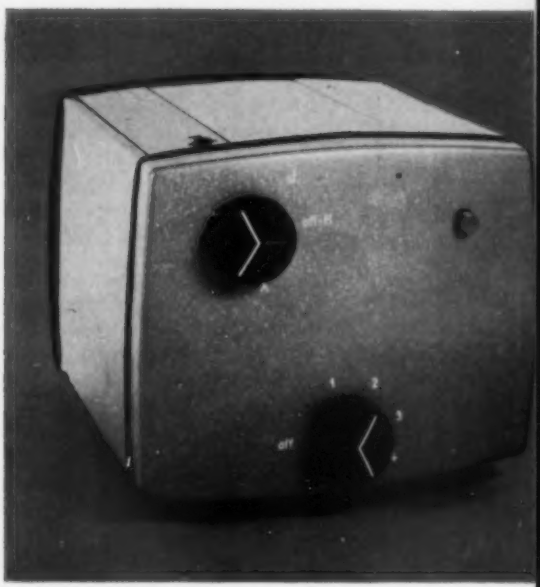


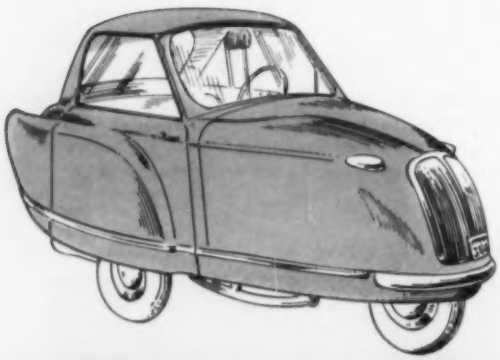
TRENDS IN APPEARANCE

This radiation-therapy machine's massive cobalt-60 container and aperture housing do not give a top-heavy look because they are counterbalanced by strong lines of supporting arms and the basket-like receptacle for patient. Distance between patient and radioactive source can be varied and entire upper section of arm and isotope container rotates on three different axes for exact positioning. By Siemens-Reiniger-Werke AG, Erlangen, West Germany.

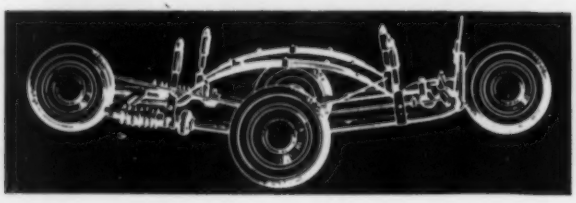
Because feed and receiving trays of this spirit duplicator fold, it takes less space than office typewriter and presents uncomplicated appearance. Bowed sides also help minimize bulk, and higher than usual legs give the machine a lighter look. Knobs are larger than usual making them a decorative element in over-all design, as well as easier to grasp and read. Designed by Burton Tysinger Assoc, New York, for Bohn Duplicator Co.

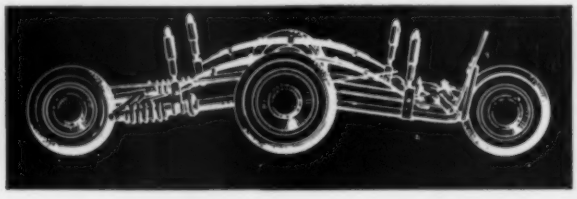


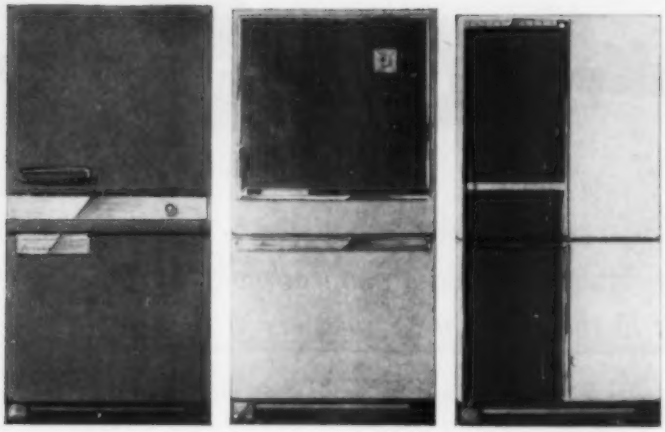


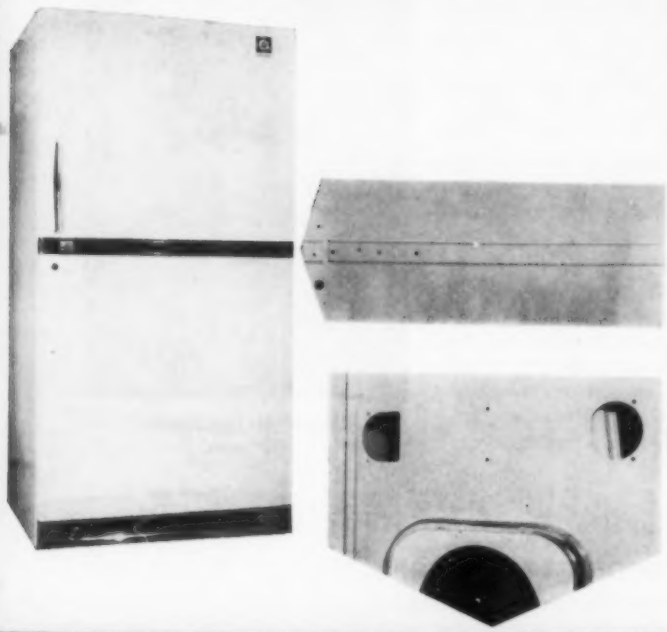


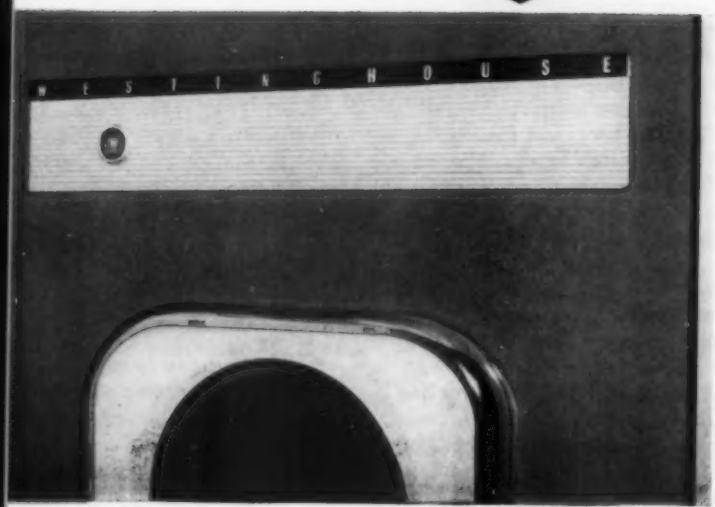
Prvenac ("the first one") is a 3-axle, 4-wheel car developed in Yugoslavia for bad-road driving in the mountains typical of much of this country. Center wheels are driven, and both front and back wheels are steered, giving turning radius of only 12 ft. Closed body is probably welcome protection from cold, windy Balkan weather.











why decorate?

W H APPEL,
Electric Appliance Div, Westinghouse Electric Corp

Industrial designers are often put on the defensive when they propose decorative treatment for products. The cost of tooling and producing can run into millions of dollars. But there are some concrete reasons for their use.

Increased value is one of them. The buyer showed preference, back in days of the individual draftsman, for products that had a richer look. Today's consumer, too, associates decoration and embellishment with increased worth. The problem here, of course, is making the decoration integral with the simple forms that characterize so many modern products.

A less-complicated reason for decorating concerns manufactured articles that need a yearly "new look" in order to sell better (above, left). Complete redesign each year would be too costly. But changes only in decorative trim will satisfy the dealer, please the customer, and effectively "obsolete" the previous year's model.

And if the product has been given important functional improvements, they may not be the kind that the eye readily sees. Here, trim can be used to inform the consumer of the inner values.

Decoration also provides price distinctions among different models. This is generally necessary in any line where there is a top and bottom price, and which consists of only two or three basic models.

Many manufacturers make several basically dissimilar products, such as a refrigerator, cooking range and washer. The need here is for a "family resemblance"—this objective, too, is almost always accomplished with decorative elements.

For manufacturing or marketing reasons, it is sometimes necessary to make up a new product out of existing components or elements. The unsightly details or poor proportions that may result can often be masked or given a more pleasing appearance with decoration, providing a saleable product in less time and at less cost than a thorough development program would have entailed. Similarly, it may be necessary for competitive reasons to make a product look taller or broader than it actually is. Again, color and trim are useful.

Joints, weld marks, raw edges and other such manufacturing blemishes (left, center) are sometimes unavoidable. The manufacturer can usually save money by covering up such problems with trim.

Decoration may help express a product's function, thus giving it character. Carefully used detail can make an instrument look more exact. A complicated machine action can look less complicated. A simple action can be accentuated.

Certain servicing steps can be performed from the front of a Westinghouse clothes dryer because an escutcheon held on with clips was used to cover the two holes required (at left). The escutcheon also provides product identification in this case.

This question of "why decorate?" is a constant challenge—often because the benefits have not been investigated thoroughly. The cost of a particular decorative treatment can be measured immediately in dollars and cents. But the treatment may be a money-maker in the long run. ■

POINTS OF

THE QUESTION:

"Should A Department of Science and Technology be Incorporated in the President's Cabinet?

"Yes . . .

We need more centralized and coordinated responsibility in the field of scientific endeavor, not only to advance the cause of basic science but to insure our victory in the technological race against the Soviet Union.

"I do not mean to say that such a Department should take in every scientific function now carried on by more than 40 independent agencies and administrative departments, but that it should bring together those broad activities in science and engineering not directly pertinent to the major purposes of other departments. The Secretary or Director of this new department should have full Cabinet status so that he can carry out a coordinated scientific program for the United States.

"I think this Department should respect private interests in science and encourage them to move ahead in research, perhaps at times urging them forward by project or example. Above all, we must demonstrate, as we have already done through the National Defense Education Act and the enactment of legislation providing for translation and distribution of scientific information, that we are ready to make a concerted and coordinated effort in the scientific field. For this, we need the most modern thinking, technology and organization we can devise—a Department of Science."

HUBERT H HUMPHREY
US Senate

"A department encompassing most or all . . .

of the government's research and development activities would be undesirable and administratively unfeasible. R & D per se is not the aim of the typical government agency; it is only a means to the agency's goal. Each agency should have authority and funds to plan and pursue its own research and development in order to carry out its mission. Domination by a superagency would only have a demoralizing effect.

"But what about centralizing just basic research, and leaving technology out? This would be equally unfeasible. Basic research is necessary to a full understanding of the technical problems and the developmental programs of the agency. To attempt to provide basic research second-hand to those concerned with development would be to expect second-rate performance. Furthermore, the extent and breadth of the problems in science of interest to all federal agencies is so great as to meet a formidable difficulty in organization, communication and dissemination of information. Not to be disregarded is the fact that the chance to do some basic research is one of the attractions that enables an agency to obtain competent scientists.

"The problem of coordinating and communicating basic research efforts can better be handled through the steps we have already taken—establishment of a science advisor in the White House and the new Federal Council for Science and Technology, consisting of top representatives of various departments charged with coordinating and planning national research."

Dr ALLAN T WATERMAN
Director, National
Science Foundation

VIEW

"The various science branches . . .

in the Federal Government differ from one another substantially in character and function, and the objectives and programs of these agencies would not be furthered by the establishment of one central supervisory authority over them. Indeed, it appears that the efficient conduct of each agency may be impaired by such reorganization. Moreover, the degree of cooperation that now exists among these agencies is sufficient for each to avoid any duplication of effort and to be assured of benefiting from the other's work.

"The National Science Foundation, in coordinating basic research in all sciences, is involved in a large number of varied projects. Its federal appropriation is almost wholly granted to universities and colleges to support the work of countless scientists and to advance science education. The National Aeronautics and Space Administration, while pursuing programs in aeronautical and space technology, is concerned with the work of the National Bureau of Standards and the research contracts of the Science Foundation. Likewise, these organizations must have knowledge of the developments coming out of NASA. And the same may be said of the Atomic Energy Commission, the Department of Defense, and other federal agencies.

"Today, there exists a continual, voluntary cross-fertilization of ideas, concepts, and discoveries among all elements of the Executive Branch of the Government having scientific missions. Furthermore, a serious attempt at coordinating basic scientific research during its early planning stages is now being made through the Federal Council on Science and Technology, an advisory body that reports to the Executive Office of the President."

Dr T KEITH GLENNAN
Administrator
National Aeronautics and
Space Administration

JOHN W McCORMACK
House of Representatives

"Yes . . .

The United States does not lack the basic intelligence or the ability to be first in science. But leadership against the competition of an aggressive foreign rival, with the freedom of the human soul at stake, will not come by mere good intentions or by drift. It will require a large-scale mobilizing of our talents, a proper financing of a broad-based program, and a careful attention to organization.

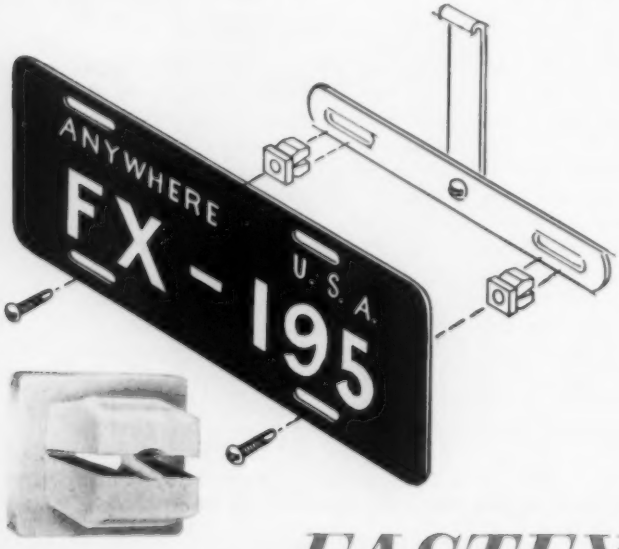
"I am aware that some critics of the plan for a Federal Department of Science and Technology do not think we can separate activities of this nature from existing departments, that science is a way of looking at things which should be universal in its application. With this view I do not disagree. But it would not be the purpose of a Department of Science and Technology to end orderly and factual study of the natural world in the existing departments of Government.

"A new Department of Science and Technology would permit an ingathering of many activities of this nature which are presently orphan stepchildren, often two or more steps below cabinet level. Some are independent agencies whose heads have theoretical access to the President. But even these men, including those with scientific or technical responsibilities, have no real role in making policy at high level, no real voice in either the Cabinet or the National Security Council.

"It is not my view that a reorganization which would add a new executive department should be directed without the full and warm support of the President at the time. However, it is only a matter of time, in my opinion, when a President will realize that such a department should be established."

Tough fastening problem... simple answer:

FASTEX® PLASTI-GROMMETS®



Using Fastex Plasti-Grommets to mount license plates demonstrates their use in blind applications, just one of their unique solutions to fastening problems. They are also ideal for any application requiring rugged fastening strength, electrical or thermal insulation, corrosion-resistance and ease of assembly. They snap into place easily and lock tight when the screw is driven.

Fastex Plasti-Grommets have been specified by leading manufacturers for years. Typical of the many mass-production industries they serve are television, where they are used as electrical insulation fasteners, and in manufacturing refrigerators where they serve as thermal insulation spacers.

SEND FOR NEW CATALOG FEATURING STANDARD PLASTI-GROMMETS!

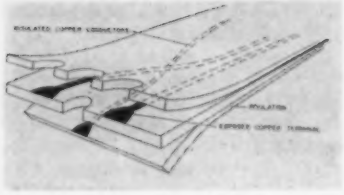
Fastex Standard Plasti-Grommets can mean big cost-savings! This new catalog contains handy ordering information and idea-suggesting case studies. See where Plasti-Grommets can cut your costs!

CIRCLE NO. 38 READER SERVICE CARD

FASTEX

A DIVISION OF ILLINOIS TOOL WORKS
195 Algonquin Road, Des Plaines, Illinois
In Canada: SHAKEPROOF/FASTEX
Division of Canada Illinois Tools Ltd., Don Mills, Ontario

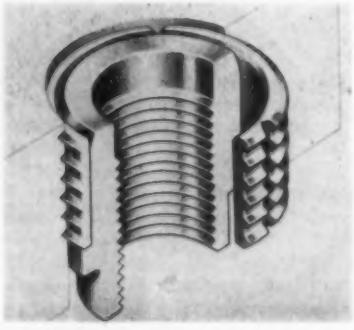
SIGNIFICANT COMPONENTS MATERIALS PROCESSES



Flexible etched circuitry . . .

can be produced in straight cables or complex wiring patterns, in single or multilayer constructions. In all cases, conductors are embedded between two sheets of thermoplastic that have been fused into one homogeneous mass. Bond between copper conductors and most plastics is said to be equivalent to a Class A hermetic seal, with guaranteed bond strength in excess of 7 psi. Other plastic surfaces can also be treated for adhesion to chassis or frames. Where minimum size and weight are important design objectives, flexible circuits can replace both conventional wiring and rigid printed wiring boards. Conductor and plastic material vary with application. Prototype samples of specific etched-circuit applications will be supplied at nominal cost. **International Resistance Co, 401 N Broad St, Philadelphia 8.**

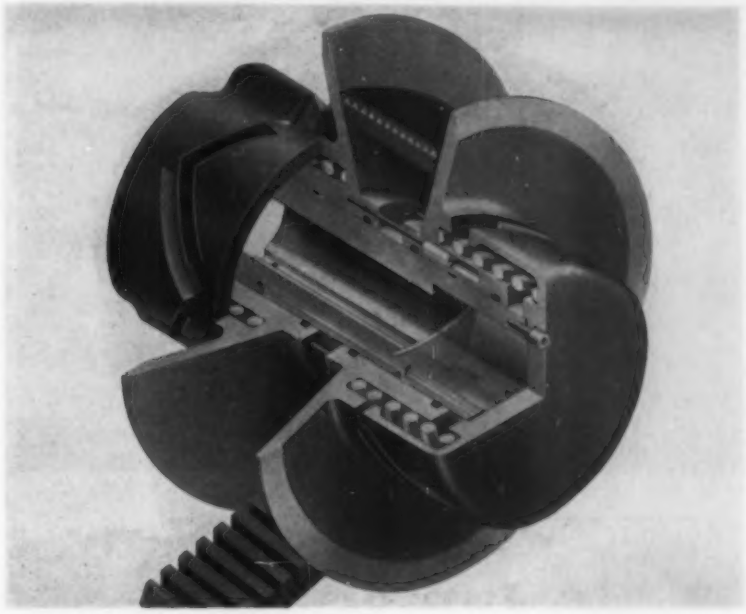
Circle 101, Reader Service Card



Fastener insert . . .

requires only hole drilling, eliminating counterboring and tapping operations. Said to provide load bearing, wear resistant, self-locking threads for holes in materials such as plate or cast aluminum, magnesium and cast iron. Insert can be used in open or blind applications. Stainless steel insert can be used in temperatures to 450 F. Push-out, torque-out and tensile strength characteristics are reported to exceed values specified in MIL-N-25027 for self-locking nuts and plate nuts. Fatigue life is said to be higher than mating bolt. Internally-threaded expander is pulled into externally grooved sleeve, which is prepositioned in work hole, resulting in interference fit between two pieces. Sleeve is forced to swell and drive its external grooves into sides of hole. Accommodate six thread sizes ranging from 6-32NC-3B to $\frac{3}{8}$-24UNF-3B. Prices are reported to be competitive with other commercial inserts. From stock. **Hi-Shear Rivet Tool Co, 2600 W 247th St, Torrance, Calif.**

Circle 103, Reader Service Card



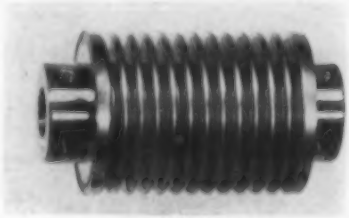
Driven sheave retains speed

during changing torque loads, but when change is required it is said to occur without sticking, regardless of how long it has been running at a set speed. Cam pressure is exerted only when load requires it. Power is transmitted equally to both movable flanges through a series of torsionally resilient rubber cam followers. Sidewall pressure on belt varies in proportion to torque required to carry load. Since grip on belt increases as load increases, pitch diameter is maintained. Offered in two sizes. For motors of $7\frac{1}{2}$ to 15 hp has min pitch dia of 5 in., max pitch dia of 10 in. For motors of 15 to 20 hp, has min pitch dia of 6 in., max pitch dia of 12 in. List, $200 and $225, respectively. From stock. Companion sheaves are available in 24 diameters, from 8 to 40 in. **T B Wood's Sons Co, Chambersburg, Penna.**

Circle 102, Reader Service Card

Miniature flexible couplings . . .

as small as 0.125 in. OD x 0.245 in. overall, owe their flexibility to a bellows made by a new progress permitting walls of 0.000,7 in. min. Said to be particularly suited to servos and computers, couplings



are supplied in torques from 0.1 to 250 in.-oz, side thrusts from 1 gm at 0.005 in. off-set, and twist angles of less than 0.3° in all sizes. Sizes range to 1 in. OD. Prices, depending upon tolerances, range from about $5 to $15 each for 100 or less. Smallest coupling is about $4.25 in lots of 1000 or more; $6 for 100 or more; $10 for 10 or less. **Servometer Corp, 222 Main Ave, Passaic, NJ.**

Circle 104, Reader Service Card

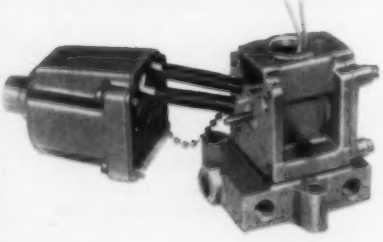
NUMATICS' New SA Junior Series

You've found it! . . . the answer to *all* your small air valve requirements. It's the new *SA Junior* Series . . . Numatics' small, precision-built, heavy duty family of valves and manifolds. Two valve types (above), many model varieties . . . three different sub-plates . . . three operator options and four styles of manifolds to provide application versatility unlimited.

SA Junior, what's more, gives you *quality* throughout . . . Numatics' famed patented lapped spool-floating sleeve action . . . corrosion-resistant aluminum body . . . continuously rated, heavy duty solenoids . . . J. I. C. conformance . . . all this plus a ruggedness and reliability to handle 60% of all your air jobs at an average 40% reduction in air valve costs. Send for a catalog today!

"Solenoid Capsule" Design—Another NUMATICS' FIRST!

Typical of SA Junior quality and design ingenuity is the unique, new "Solenoid Capsule" . . . a Numatics' *exclusive*. Solenoid and cover are a self-contained, J. I. C. approved assembly which eliminates loose parts when the solenoid cover is removed.



NUMATICS, Inc.
HIGHLAND, MICHIGAN

SIGNIFICANT COMPONENTS
MATERIALS
PROCESSES . . .

Teflon-glass fiber filter . . .

contains positioning relay and reverse relay medium can be used in place of paper-wire screen, paper-cloth and porous ceramics. (*PE*—Aug 31, p 17). A silicone-alkyd-glass fiber reinforced material is also available. Both are said to be resistant to a wide variety of chemicals and to 500 F. Produced in 0.001 to 0.025-in. thicknesses, 38 in. wide, 1000-ft rolls. Pore sizes controllable from less than 1 to 70 micron dia. **American Machine & Foundry Co, Springdale, Conn.**

Circle 105, Reader Service Card

Hot-gas relief valve . . .

for service up to 200 F has no rubber or organic parts. Constructed entirely of stainless steel. When used to control pressure of solid propellant gas generators, valve provides narrow pressure control band without drift. Cracking pressure is adjustable from 1,000 to 15,000 psi. Hysteresis is less than 5%. Poppet design is said to eliminate valve chatter. Mass flow capability is greater than 0.015 lb per sec at 1,000 psi. Unit mounts on MS-33656-4 fitting. Weighs 2 oz. In quantities of 1000, $25.80 each. Delivery, at rate of 100 per mo, 45 days after order. Smaller quantities in 30 days. **Pyronetics, 11973 E Slauson, Santa Fe Springs, Calif.**

Circle 106, Reader Service Card

Pneumatic motor . . .

has cylinder volume of 26 cu in. yet provides 150 ft-lb of torque (based on 20 psi air supply) and 7-in. stroke. Can be mounted any position. Power package contains positioning relay and reverse relay power motor. Air connections are ¼ in. NPT. Effective area is 18 sq in. **Powers Regulator Co, 3490 Oakton St, Skokie, Ill.**

Circle 107, Reader Service Card

Variable transformers . . .

provide max voltage equal to line voltage in contrast to over-voltage types that provide max voltages of about 17% above line voltage. Can be supplied cased or in tandem assemblies. **Ohmite Mfg Co, 3650 Howard St, Skokie, Ill.**

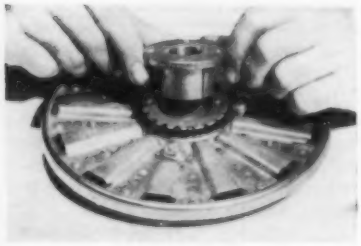
Circle 108, Reader Service Card

SPST pressure switch . . .
is hermetically sealed. Switches electrical circuits in response to pressure changes in hydraulic fluids, fuels or other gases or liquids. About $\frac{7}{8}$ x $\frac{1}{2}$ in. and weighs $\frac{1}{4}$ oz. Mounts directly on pressure fittings or in pressure fitting hardware. Pressure range is 1 to 500 psi; overpressure without shift, 3,000 psi. Operating temperatures range from —65 to 165 F. **Bourns Inc, PO Box 2112, Riverside, Calif.**

Circle 109, Reader Service Card

Precision repeat counters . . .
are said to eliminate transfer masks or shades and have no interrupted gearing to complicate operation. Series AD-1 counts hours, degree, mils, minutes and then returns to zero and repeats. Because they do not count in multiples of 10, counters are suitable for applications where repeat is from zero with continued rotation after count other than 99,999 or 9999, such as 259°, 6300 mils, 23 hr, 59 min. Counters are bidirectional and add with clockwise rotation of input shaft. Operating temperatures range from —60 to 165 F. Standard models, in sample quantities, are $57.50, 3-wk delivery. **Chicago Dynamic Industries Inc, Precision Products Div, 1725 Diversey Blvd, Chicago 14.**

Circle 110, Reader Service Card



Spline drive armatures . . .
for use on integral horsepower electric clutch-coupling and brake applications where shock-loading or vibration-loading limit successful use of pin drives. Available in 8, 10, 12 and 15-in. dia. Can also be used in special clutch applications where male splined hub is supplied by user. No mounting adjustment is required. Adapter is made of Meehanite. Automatic gap spring compensates for magnet and armature wear. It maintains $\frac{1}{32}$-in. gap when unit is disengaged. Prices, for the 4 sizes, are $64, $84, $111 and $133, list. About 60-day delivery. **Warner Electric Brake & Clutch Co, Beloit, Wis.**

Circle 111, Reader Service Card

6-amp slide switch . . .
carries UL-rating of 6 amp at 125 v ac. SPDT contacts may be connected for SPST operation. **Stackpole Carbon Co, St Marys, Penna.**

Circle 112, Reader Service Card

Can These

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BY FELTERS

IDEAS

Help You?

FELT GREATLY REDUCES GLAZING COSTS

over conventional brushing. Fine china manufacturer uses special Felters DuFelt Polishing Belt to reduce glazing costs. Felt coarseness and density can be varied for most effective polishing of metal, glass and ceramics. Can also be coated with abrasives.

FELT ADHESIVE TAPES AND PADS

are the most inexpensive material for sealing, padding and cushioning. Felt strips seal out dust, dirt, wind, fumes, moisture, and eliminate squeaks and rattles.

FELT AS A LOW COST FRICTION MATERIAL

Used as a braking or friction device, sometimes combined as a seal or washer. High coefficient of friction and extra density provide foolproof clutching and tension action at low cost, like the Lever Puller shown at left.

To get the most out of Felt, send for the Felters Design Book — a complete digest on properties and applications. Write, today.

Ask for **FELT** *from . . .*

The **FELTERS** Co.

259 SOUTH STREET
BOSTON 11, MASSACHUSETTS

Pioneer Producers of Felt and Synthetic Non-Woven Fabrics m-6-16

Anchored by "Coining"

A casual glance at the fabricated piece illustrated here would not disclose anything unusual. Just a small dome of wire cloth—tungsten, by the way—fastened to a small copper ring.

But a careful examination will disclose something quite unique in the assembly...

Instead of being soldered or brazed to the underside of the ring after the section of cloth is inserted and folded over, individual wires are pressed or are 'coined' into the copper. A slight flowing of the copper anchors these wires firmly. Why go to all the trouble of developing this special method of assembly? Rigid specifications called for a *flat* contact surface on the underside of the ring, while at the same time carrying the mesh down through the hole in the ring, and crimping it over. The cloth couldn't be fastened on the upper side of the ring. It had to be underneath.

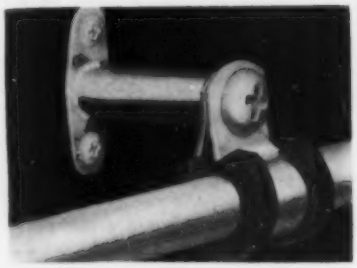
NEWARK for ACCURACY

Experienced specialists in our parts fabrication division devised this entire procedure—the way to anchor the cloth—the intensity of pressure—the machine to do the work. It's an excellent example of Newark ingenuity...a skill available to you in connection with your requirements of 'wire cloth parts.'

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

SIGNIFICANT COMPONENTS
MATERIALS
PROCESSES . . .



Right-angle fasteners . . . are self-locking and suitable for medium to light loads. Designed around stainless mid-grip insert that locks and maintains constant spring-pressure on screw threads. Incorporates both self-locking device and mounting bracket in one unit and attaches directly to structure. Because of strength and rigidity (they are forgings or impact extrusions), fasteners may be spaced further apart. Many configurations in lengths from zero to 3 in., in 0.020-in. increments. Western Sky Industries, Hayward, Calif.

Circle 113, Reader Service Card

Lightweight relays . . . that meet applicable military specifications are 10 amp, 4PDT units. Weigh 0.4 lb, 20% less than past standards for similar 4PDT units. Over-all enclosure is 1.44 x 1.44 x 2.25 in. Prototype quantities, off-the-shelf; production quantities, 6-wk delivery. Both ac and dc models. Electro-Mechanical Specialties Co Inc, 743 W 39th St, Banning, Calif.

Circle 114, Reader Service Card

Colored zinc plating . . . for wire forms, components and assemblies is offered in six basic colors that are said to resist corrosion and rust. Colors may be supplied in any desired degree of density. Zinc plating applied to basic steel wire, given colored chromate treatment and baked clear lacquer coating. H Titchener & Co, 57 Clinton St, Binghamton, NY.

Circle 115, Reader Service Card

Relay actuator . . . senses magnetic field created by current in wire that is placed through hole in toroid, which is enclosed in epoxy material. Relay to be actuated is placed in series with toroid unit. Unit can give relay actuation as low as 4.5 amp. Usable for ac and dc systems. 4.5-amp actuator and relay unit, $45. From stock. L & B Electronics, 2424 6th St, Berkeley, Calif.

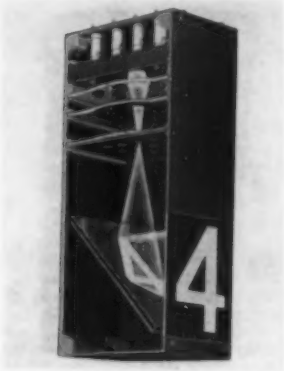
Circle 116, Reader Service Card

Silicon-controlled rectifier . . . for inversion of dc to ac, dc static switching, pulse width modulation, power equipment frequency conversion and current limiting circuit breaker use. Available in peak inverse voltage ratings of 100, 150, 200, 250 and 300 v ratings for operation in junction temperature range of — 87 to 257 F. Prices, from $38 for 100-v unit to $116 for 300-v in large quantities. From stock. **General Electric Co, Semiconductor Products Dept, Liverpool, NY.**

Circle 117, Reader Service Card

Dyeing of Teflon parts . . . and wire to a wide range of colors does not affect dielectric properties nor make machining difficult. Service also includes color-coding epoxy printed circuit boards without affecting circuit performance. **Colorite Industrial Dyers, 244 W 38th St, New York 18.**

Circle 118, Reader Service Card



90° digital readout . . . is said to save depth space because of erect position. Condensing lens has room for 12 digits or characters. Projected readout is 3¾ x 2 in. Individaul readouts, $33 each. **Industrial Electronics Engineers Inc, 3973 Lankershim Blvd, N Hollywood, Calif.**

Circle 119, Reader Service Card

Solid-state preset counter . . . is housed in reinforced steel enclosure. Offers 6 million counts per min. max. Standard preset count range is 1 to 9,999. Requires 18 v dc at 0.2 amp; standard power supply operates from 115 or 230 v, 50 to 400 cps line. Size, 3½ x 9½ x 13 in. Weighs less than 10 lb. **Erie-Pacific, Div of Erie Resistor Corp, 12932 S Weber Way, Hawthorne, Calif.**

Circle 120, Reader Service Card

Stainless cap screws . . . utilize cold-forged stainless steel and rolled threads. Available in range of sizes. **Set Screw & Mfg Co, Bartlett, Ill.**

Circle 121, Reader Service Card

SELSYNS and SYNCHROS

High-accuracy types for precise remote control applications

General Electric offers a wide variety of Selsyns and Synchros to meet industry and Navy BuOrd specifications:

- **THREE FRAME SIZES**—BuOrd Sizes 1 and 5 and a smaller G-E 15.
- **HIGH ACCURACY**—Ranging from ±1.5 degrees down to ±0.3 degrees, depending on model selected.
- **SPEEDS**—Models for operating up to 300, 1000, and 1200 rpm.
- **FREQUENCY**—Both 60 and 400 cycle represented.
- **VOLTAGES**—115 Volt Primary and others available.
- **FOR USE** in torque transmission and voltage control systems.

FREE BULLETIN! For more information, write for publication GEA-6675, to Section 634-24, General Electric Co., Schenectady, N.Y.

GENERAL ELECTRIC

CIRCLE NO. 80 READER SERVICE CARD

Strataflo

SPECIAL

CHECK VALVES for Submersible Pumps

SILICONE TREATED RUBBER POPPET

Tapped one or two holes for attaching Pressure Switch, Pressure Gauge or Snifter Valve.

No. 350

Here's the answer to your Check Valve problems on submersible pumps. The taper-type rubber poppet is noiseless, does not leak, opens easily. Works in any position.

All bronze body. Five sizes, ¾" through 2". May be tapped for one or two side connections as shown. Used as original equipment by many leading pump manufacturers.

Write today for Bulletin 203, or telephone Harrison 3313 for more information.

STRATAFLO PRODUCTS, INC.
FORT WAYNE, INDIANA

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OROSENE 999☆
24 Kt Acid Bright Gold

The first NEW development in gold electroplating in over 100 years. It produces electroplates both hard and ductile using ONLY ONE addition agent operating at room temperature under POSITIVE and simple control.

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H.G. BRIGHT 23+ Kt GOLD

The only bright gold operating with less than 1/10 ounce free cyanide per gallon at room temperature, offering variable hardness to fit your specifications . . . at a non-premium price.

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7001 North Clark Street

SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .

Plastic forming tool . . . is electrically heated. Used to form thermoplastic sheet and in placing fiber glass cloth over molds to form complex, irregular shapes. Tools, consisting of heater unit and five quick-change heads, $14.95. **ERA Engineering Inc, 1009 Montana Ave, Santa Monica, Calif.**

Circle 122, Reader Service Card

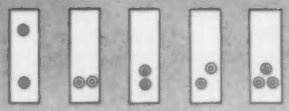
Temperature indicators . . . for use with thermistors is said to have accuracy of 2% of full scale. High resistances of thermistors permit use of ordinary copper wire leads of any practical length with negligible effect on accuracy of meter readings. Coupled with proper thermistor probes, indicators can be used to measure temperatures of static or dynamic liquids, gases or soft solids as well as surface temperatures of solids. Panel-mounted, multi-input unit has provision for up to six temperature sensing channels and single or dual temperature ranges. Both portable and panel-mount models are self-energized by small mercury cells, with operating life of up to 6 mo. **Kahn & Co Inc, 541 Windsor St, Hartford, Conn.**

Circle 123, Reader Service Card

Portable vibration analyzer measures, within specified milli-in. bands, peak-to-peak displacement and frequency of mechanical vibrations at such locations on motors, generators and jet engines where vibration pickups may be mounted. Four unitized, velocity-type seismic pickups and cables are furnished. Pickups are said to have flat frequency response 20 to 2,000 cps with sensitivity rated at 21.4 per mv per 0.001 in. da per 100 cps into 20 k ohm load. Calibrated to 1% accuracy and designed for omnidirectional mounting. May be plugged into 115-v, 60 cps ac power source. Less than 40 lb. $2490 with 4 pickups. Delivery, 60 days. **Aeronautical-Instrument Div, Sun Electric Corp, Harlem and Avondale, Chicago 31.**

Circle 124, Reader Service Card

Choice of Terminal Arrangements



for

VULCAN STRIP HEATERS

The terminal arrangements illustrated are just one indication of *Vulcan Versatility* in electric strip heaters. You also have a wide choice of standard seamless one-piece sheaths — steel for sheath temperature to 750°F, chromalloy to 1200°F; lengths 8" to 42½" (special — shorter or longer); wattage — 150 to 1500 watts (or higher); rugged non-oxidizing terminal posts. Heaters can also be formed into circles (one or two piece) in radius of 5" or more.

Vulcan Electric Strip Heaters are ideal for contact heating of dies, platens, molds, or any item with flat surfaces to which elements may be clamped; also as air heating sources for ovens, air ducts, dryers, etc.

Solve your hot problems with *Vulcan Versatility* in the application of electric heat. Send coupon for catalog and prices.

VULCAN ELECTRIC COMPANY
Danvers, Mass.

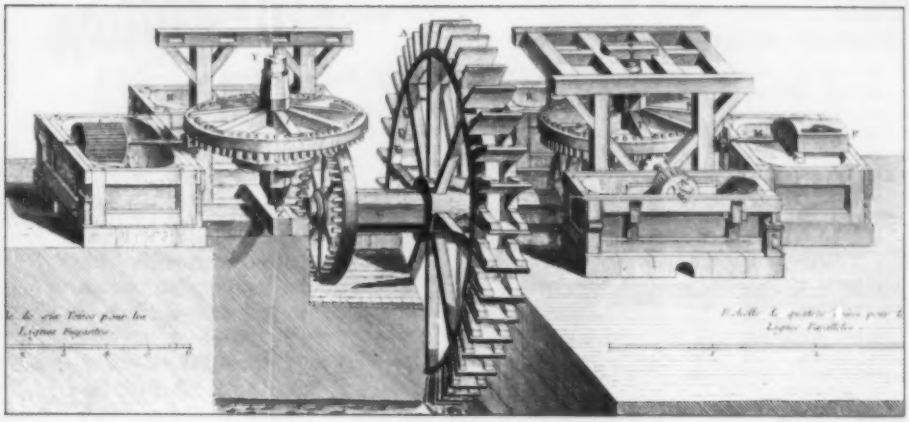
VULCAN ELECTRIC COMPANY
88 Holten Street, Danvers, Mass.

Please send me catalog and price information on Vulcan Electric Heaters.

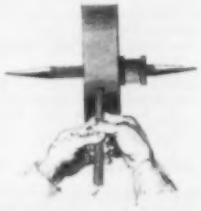
Name & Title.....
Company.....
Street & No.....
City & State.....

CIRCLE NO. 82 READER SERVICE CARD

NEW LITERATURE



Power from a water wheel



Diderot's Encyclopedia of Trades and Industry

Edited, and with notes, by C C Gillispie, Assoc Professor of History, Princeton University. Based on "L'Encyclopedie, ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers" of Denis Diderot, originally published, 1762-65. Dover Publications Inc, 180 Varick St, New York 14. 2 vol, 920 pp, boxed; 9 x 12. Vol 1, $10; Vol 2, $10; $18.50 the set.

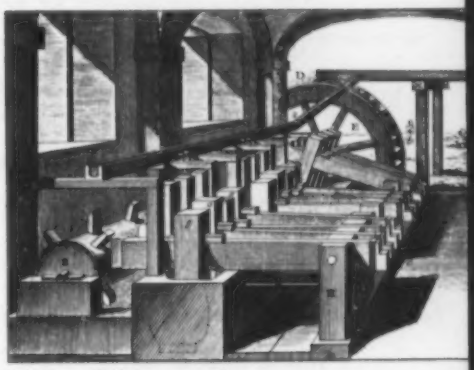
This is a picture book of European productive forces on the eve of two great popular upheavals, the French revolution and the so-called industrial revolution. In reality, as this book makes clear, the latter was simply the application of newly developed sources and magnitudes of power to the rudimentary systems of rationalized production already in existence in Diderot's time.

Diderot once described his encyclopedia as an attempt "to assemble the knowledge scattered over the surface of the earth; to explain its general plan to the men with whom we live and to transmit it to the men who come after us." So well did Diderot and his collaborators (who included a number of the great scientists, philosophers and political liberals of his time) accomplish this that working replicas of much of the machinery and processes could be made from the present edition's text and plates.

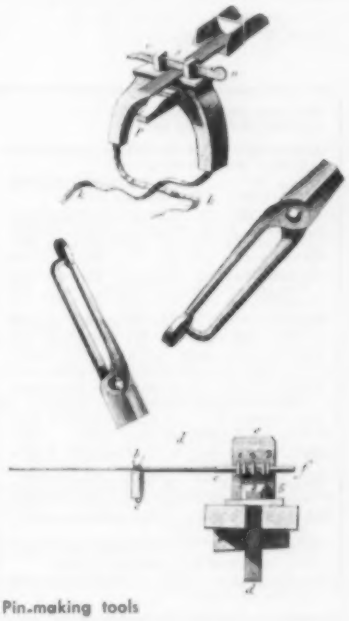
But as painstakingly accurate as the encyclopedia is, the author and his collaborators managed to suffuse it with their democratic, humanitarian philosophy, later expressed by the masses in the French Revolution as "liberty, equality, fraternity." Even the basic idea of making learning widely available on a systematic basis was feared by the monarchical state and the church which supported it. As a result, Diderot's license to publish was suspended for a time by the royal censor.

The modern engineer will find clearly illustrated in these two volumes the ancestors of many of the basic mechanisms, linkages and other mechanical systems with which he plies his trade today. Centuries of empirical, cut-and-try engineering, as well as considerable untutored ingenuity are demonstrated in such plates as those devoted to wind and water mills, cider and sugar cane presses, musket barrel-boring and grooving machines, metal-working systems, toolmaking, cutlery shops, power-transmission apparatus, spinning, papermaking, goldsmithing.

Details from some of these plates accompany this review, taken from the 485 selected by the editor from the 2900 in the original 28 volumes of the encyclopedia. Reproduction of this graphic material is excellent. In fact, good enough to make one wish that at least some of the descriptions, explanations and commentaries from the original text had been used, rather than relying entirely on Gillispie's sometimes over-popularized, sometimes pedantic notes. –JK



Pulping mill for papermaking



Pin-making tools

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For Your Information (personal)

Taking a flyer on the weather

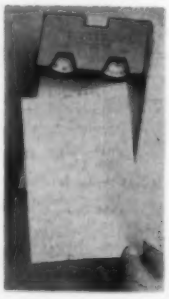
In these complex times, when one not only has to cope with the weather, but also with new prediction systems and new indices like the THI, German engineers have decided that the old-fashioned barometer-thermometer-hygrometer combinations just won't do. That, at least, seems to be the theory behind the Sputnik Barometer pictured here. Says Hoffritz, the importer, "It forecasts the weather to come, gives you the present temperature, and acquaints you with the moisture content in your home." For just $24.95, you can put it on your desk or hang it from the ceiling.

Fan your oven

Put a fan in the oven if you want to cook food cheaper and faster, says F. D. Borsenik of Michigan State. Use of forced circulation, he says, can make it possible to reduce oven temperature and still reduce cooking time. It's well known, of course, that air circulation can improve heating and cooling effectiveness; but this may be the first serious proposal that home and institutional cooking equipment be provided with built-in fan blades; and it could bring major changes in oven shape and styling.

More write-anywhere pencils

Not to be outdone by the write-on-butter ballpoint pens, the pencil makers are coming out with a slew of writing implements that will mark everything from cardboard to coffee cups. Latest in the line is the Mars-Omnichrom, available in black, white and 5 colors. It's said to mark plastic films, foils, ceramics, and rubber. Sample free on request from J. S. Staedtler, Hackensack, N. J. Six-pencil assortment—$1.20; Box of 12, all one color—$2.00; or circle No. 200 Reader Service Card.



Dating your doodles

A memo pad that takes advantage of liquid-filled plastic microspheres to provide an almost-everlasting stamp pad for dating is now being offered by Brown and Bigelow. The pad material, originally developed by Perma Industries (*PE—Nov 4 '57, p 43*), and now being produced by S. C. Johnson, is made by fusing millions of these tiny spheres, trapping the ink until pressure releases it. Work on other applications for the material is now in process. —ARG

Why Don't They

R ESEARCH and D EVELOP . . .

. . . temperature indicators that can be applied like adhesive tape to show highest temperature reached. The tape—coated with narrow bands of wax each with melting temperature progressively higher than the first—could be attached to those hard-to-get-at spots in equipment testing without requiring external instrumentation. As the wax melts, colors or numbers underneath would become visible. Also might have application in medical work. —R MARIE

. . . a small indicator that meters flow of water from a faucet. It would eliminate need for many sizes of measuring vessels and greatly simplify mixing of all types. A small turbine would be turned by water flow and revolutions translated into units of volume by gear train and appropriately marked dial. Must be small, inexpensive and accurate enough for cooking as well as other tasks where larger volumes are to be measured.

—M Rossow

. . . a pencil pointer for draftsmen that sharpens by cutting parallel to the lead, rather than around it. Conventional, rotary pencil-pointers cut grooves around the circumference of the lead, creating stress concentrations that weaken it. A point cut with strokes parallel to the lead would be stronger. —H. BRIKOWSKI

. . . an insect-repellent in powder form. Children sensitive to bites of mosquitos, ants, etc., could be protected without covering them with an oily liquid that picks up dirt, stains clothing.

—E SCHAFFERT

. . . a safety razor that has in its handle a small, pressurized capsule of high-wetting liquid soap. This would eliminate need for shaving cream. Flow of soap, controlled by a button on the handle, would keep razor cutting smoothly and also help flush away the beard particles. —E DEZABALA

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worth-while paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who may have a fresh viewpoint or more time for necessary R & D. We will pay $10 for each one accepted.

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5	12	19	26	33	40	47	54	61	68	75	82	89	96	
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Publisher's Postscript...

Googols and googolplexes

There's a fascinating essay on large numbers in *The World of Mathematics*, by Edward Kasner and James R Newman, which describes the googol—a word I had never seen before, though I'm told it's in several technical dictionaries.

The word was invented by Dr. Kasner's nine-year-old nephew when asked to think up a name for a very big number. "Googol" sounded very big indeed, so he settled on that and then went on to produce "googolplex"—an even larger number. A googol is 10^{100}; a googolplex is 10 raised to the googol power.

Now these are pretty big numbers, but 10^{100} is so easy to write that sometimes you forget how big it really is. Says author Newman, "it has been estimated that if the entire universe . . . were filled with protons and electrons, so that no vacant space remained, the total number of protons and electrons would be 10^{130}."

This is actually the biggest number of counted *things* that could exist because it is the sum of the smallest thing in the largest space we know.

Some other examples? The number of grains of sand on the beach at Coney Island is estimated at 10^{20}. The number of words printed since the Gutenberg Bible: under 10^{17}.

Since the googol is so all-inclusive a number, I wondered what possible use the googolplex might be. It turns out that permutations and combinations in probability calculations do get up that high. The authors say to imagine a book which you hold suspended by a string. How long will it take before the book jumps up into your hand?

Never? Nope. "It will almost *certainly* happen *sometime* in less than a googolplex of years—perhaps tomorrow." (Italics theirs.)

In an article in PRODUCT ENGINEERING last year, which I thought was supposed to be facetious, a certain Dr. Finagle was quoted, "If anything can go wrong with an experiment, it will."

This Dr. Finagle had some other mottoes you may be interested in: Science is Truth—don't be misled by facts. Do not believe in miracles—rely on them. We've still got a few copies of the article, so if you want one, write in *Finagle's Laws* on the Reader Service Card and send it in.

Dr. Finagle may have been imaginary, but his law isn't. It seems to be only an example of the more general law: Anything can happen and, given enough time, it will. —SJA

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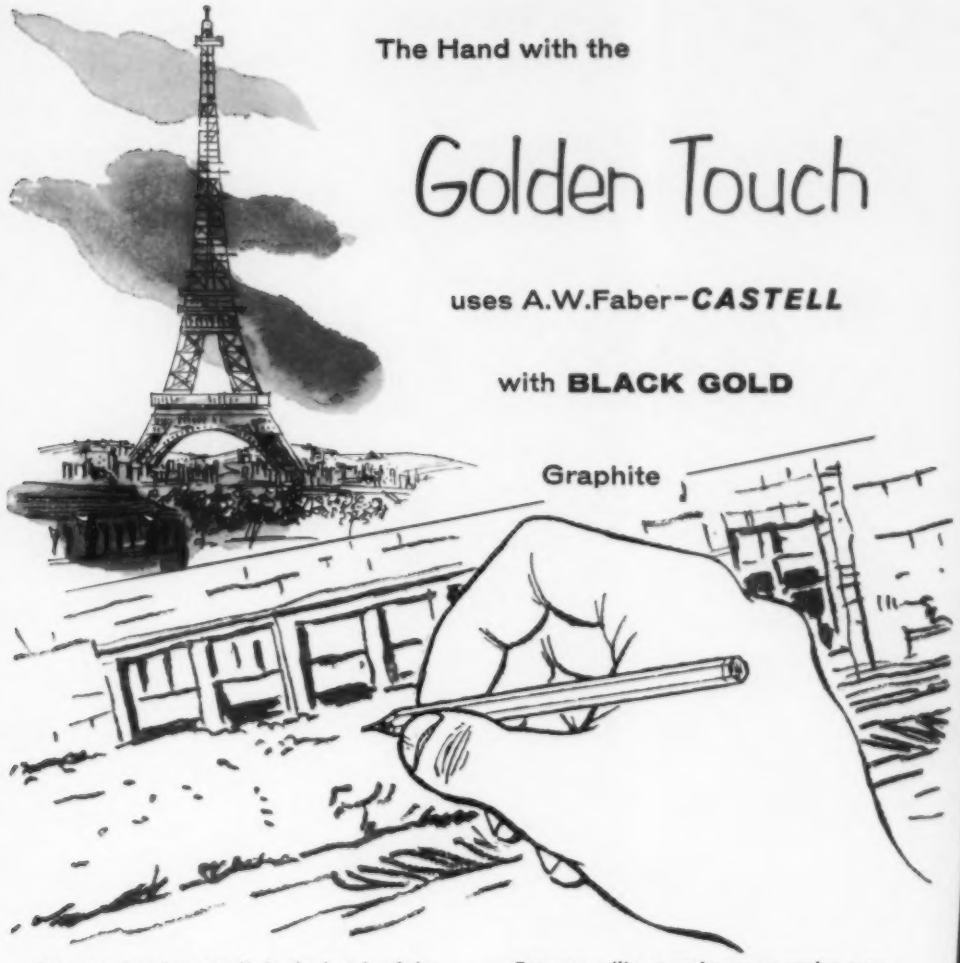

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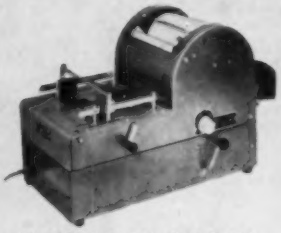
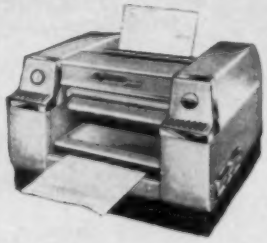
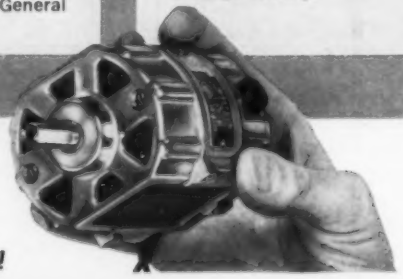


REX-O-GRAPH DUPLICATORS. "We tested all induction type motors. Bodine was the only one that met our requirements in starting torque, weight, breakdown torque, size, and reduction gear dimensions. Service on this motor has been almost nil."—General Binding Corp.



BRUNING COPYING MACHINES. "The only reason we buy Bodine Motors is that we could not buy a product of equal quality elsewhere." —John P. Arndt, works manager, Chicago factory.



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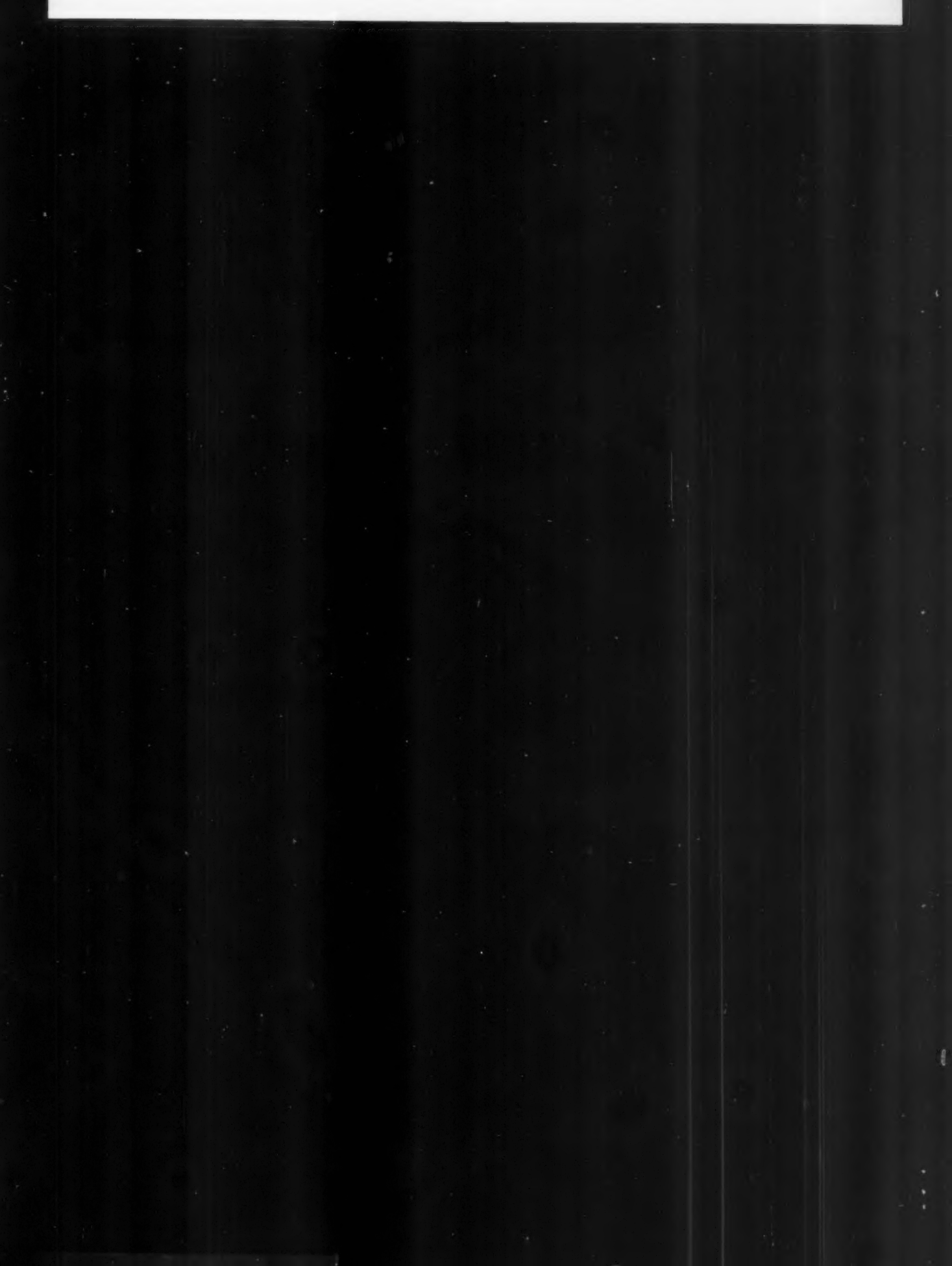
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